UTILITIES TECHNICAL STUDY

PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX SAN FRANCISCO, CALIFORNIA

VOLUME VI
STORM DRAIN SYSTEM

FOR
NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CA.

FINAL REPORT

PREPARED BY

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DATE: DECEMBER, 1988

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CONTRACT NO. N62474-86-C-0969

UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

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UTILITIES TECHNICAL STUDY
PHASE 2
FINAL REPORT

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UTILITIES TECHNICAL STUDY
PHASE 2
FINAL REPORT
VOLUME V – SANITARY SEWER SYSTEM

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UTILITIES TECHNICAL STUDY, PHASE 2

HUNTER'S POINT ANNEX

SAN FRANCISCO, CALIFORNIA

VOLUME VI - STORM DRAIN SYSTEM

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UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM DRAIN SYSTEM

SECTION 1.0 - INDEX

PURPOSE, PROCEDURES AND CRITERIA

1.0 PURPOSE, PROCEDURES AND CRITERIA

1.1 Purpose

A. This Utilities Technical Study (UTS) report has been prepared under Contract No. N62474-C-86-0969 dated May 8, 1987. In general, the purpose of the study is to prepare engineering investigations and planning analyses, cost estimates and reports to provide a Master Utility Plan (MUD) for full mission support capability to the year 1992. The master plan projects which provide the full mission support capability are in accordance with Naval Station Treasure Island, Hunters Point Annex (HPA) Master Plan dated November 4, 1987 supplied by WESDIV Code 20 Planning Division. Capital improvement projects identified in the Master Plan do not extend beyond FY1992.

Volume VI engineering analyses were performed for the Storm Sewerage System. The scope of the analyses includes storm sewers and associated runoff areas. The scope of work excludes all future housing areas, all dry docks and some piers.

1.2 Procedures

A. The following procedures were utilized in the preparation of the Master Utility Plan:

1. Research of historical and as-built data on utility systems including maintenance records, inspection reports and review data.

2. Field investigation.

3. Video scanning to determine existing conditions in sanitary sewers. Physical observation of sanitary sewers to determine their conditions. Findings and conclusions from this survey were applied by association to storm sewers.

4. Use of 2-feet interval contour maps for determining drainage characteristics of runoff areas.

5. Analysis of and calculations on existing drainage systems.

6. Preparation of runoffs by the rational formula approach for various storm frequency conditions.

7. Preparation of proposed utility development plan projects.

8. Analysis and calculations on proposed utility system modifications.

9. The following drawings were prepared to illustrate existing and proposed future storm sewer conditions at the Annex:

   a) SD-1 & SD-2: Storm Drain System, 1987 Existing Conditions

   b) SD-11 & SD-12: 1987 Existing Conditions - Network Analysis Diagram

   c) SD-3 & SD-4: Storm Drain System, Future Conditions

   d) SD-13 & SD-14: Future Conditions, Network Analysis Diagram

   In each case the double digit-numbered drawings are an auxiliary companion set to illustrate computational features used in the analysis of existing and proposed physical configurations of the storm sewer system.

10. Preparation of D1391's cost estimate and UDP site plans.

11. Draft report.

12. Final report.

B. Procedures for Conducting Survey

Methodology employed in conducting the study of the Base storm sewer system included a detailed examination of the plans on record maintained by the Station's Public Works Department. Not all modifications to the storm sewer systems over the years were on record, and some of the details had to be provided by the Public Works Department personnel. However, this information was supplemented by field investigations and surveys to verify some of the changes and to fill in the gaps.

Some features originally incorporated in the design plans were never installed; on the other hand many additional sewer modifications have been made since the original installation. The sewer characteristics used in hydraulic computations were taken from maps on record, supplemented with field information, whenever necessary.

1.3 Evaluation Criteria

A. The key design manuals and codes used in the process of making analyses, identifying deficiencies and evaluating the adequacy of the storm sewer system included the following:

1. NAVFAC DM 5.02 - Civil Engineering, Hydrology & Hydraulics

2. NAVFAC DM 5.03 - Civil Engineering, Drainage Systems

3. NAVFAC DM 5.8 - Civil Engineering, Pollution Control Systems

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NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

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VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 2.0 - INDEX

EXISTING SYSTEM

2.0 EXISTING SYSTEM

2.1 Description

Within the confines of the mean high tide shore line (El. 106.00), the Hunters Point Annex occupies approximately 470 acres of dry land. About 430 acres of this land, plus or minus 90% of the Base, is drained by the existing storm sewerage system. This includes the totality of land currently associated with the mission of the annex. Not covered by storm sewers are sections of undeveloped shoreland, certain pier areas, the trailer parking lot at the foot of Donahue Street, and generally such areas where minor temporary flooding is tolerable within the extent of normal annex operations. The existing storm sewer system is illustrated in Drawings SD-1 & SD-2.

The Hunter's Point Annex is situated on land sloping towards San Francisco Bay. The storm sewers drain by gravity into the Bay. Topographically, the annex can be considered sitting on two planes, the Main Annex lower plane and the Housing Area upper plane. Elevations throughout the lower plane generally range from highs of about El. 123 to lows in the vicinity of El. 107, the best working average elevation being El. 113. Elevations in the upper plane range from highs around El. 283 to lows of El. 203 along the rim of the sharp slope connecting the planes and then down to El. 123 along the toeline. A substantial portion of the lower plane has been recovered from the Bay through massive filling projects during the development stages of the Annex. Other areas, on the north side of the lower annex have been developed by cutting into the housing area hillside creating the sharp slopes connecting both planes. The background of these man-made soil movements in the evolution of the annex helps to explain the soil subsidence problems in portions of the Main Annex alluded to later in this section. Site topography is best illustrated on the contoured maps on Drawings SD-1 & SD-2. Elevations on the map are expressed in National Geodetic Vertical Datum (NGVD). To convert NGVD to mean sea level elevations, the reader must add 103.1 to any NGVD elevation, thus El. 8.0 NGVD would be El. 111.1 mean sea level.

The existing storm sewerage system is the result of an evolutionary process starting with the development of the annex in the 1940's. The system evidently grew in sections as dictated by the needs of the moment. This would explain the emergence of the ten independent drainage systems and the many minor drain systems in shoreline and pier areas which make up the existing overall drainage system. The existing ten drainage systems under scope in this study have been designated in alphabetical order from "A" to "J". Their boundaries and characteristics are shown respectively on Drawings SD-11 and SD-12 and in Table 6.1 in Appendix A.

Also shown on the drawings are the other minor drain systems around the shoreline periphery of the Base. As stated, the attention of this study centers on the ten major area systems, as all others are inconsequential within the scope of this study. Except for portions of one area, all others are Main Annex areas. About one half of Area "B" is the Housing Area, the other half lies in the Main Annex. As may be seen, not all contributory drainage areas are totally within the legal bounds of the Annex. Some natural drainage from City streets flows into the annex, most notably in the westerly portion of the housing area, along Innes Street by the Main Gate and north of Navy Road, beyond the western boundary of the annex.

2.2 Existing Conditions

A. General

The existing storm sewer system was originally designed and built as a combined storm and sanitary sewage collection system. This important consideration, along with some others, will weigh heavily in the evaluation of every aspect of the system. The sewer materials are vitrified clay and concrete. Their sizes range from 8 to 72 inches in diameter. Most of the system appears to have been built in the 1942-1946 period. A precise historical background on the system's growth and gradual development is unavailable.

In 1958, as part of a major upgrading program of sewerage facilities at the Hunters Point Annex, and prompted by the then current Federal Pollution Control Act, partial segregation of the combined system into separate storm and sanitary systems began. The separation of the systems took place mostly in the industrial areas, and in the southwest area of the Hunters Point Annex, essentially Drainage Areas C, D, E, F, G, H, I and J. Segregated sanitary sewage ended up in the newly built main pumping station on Spear Avenue. Existing outfalls, numbering about 40, remained intact, 28 being now exclusively storm sewer outlets while the other 12 meanwhile, remained as combined outfalls.

In 1973, a major storm sewage separation project was undertaken which shaped the existing storm sewerage system into its current configuration. Construction of the project was completed in 1975. Drawings SD-1 & SD-2 highlight the 1975 additions. Most of the activity of this project took place in Areas "A" and "B". Most of the trunk sewers in area "A" along "K", "R" and "I" Streets and Crisp Avenue, the 72-inch outfall, and indeed, those in the entire system "A", are the result of that project.

In 1976, a follow on project, P262, achieved further separation of sanitary and storm sewers, concentrating mostly on Area "B". Since then no other modifications to the system have occurred. At this stage, storm and sanitary sewer systems were considered fully separated.

Combined sewer systems are normally harsh on their components. The Hunters Point Annex is no exception. In addition, age and soil subsidence have also taken their toll. The physical deficiencies of the system encountered during the course of this study are those generally expected in connection with aging sewer systems exposed to poor maintenance, hydraulic abuse and subsiding soil conditions. These include corroded pipe and manhole walls, leaky and broken joints and pipes, and improperly disconnected pre-1976 flow diversion structures. Also found were flow path obstructions in the form of overflow weirs and frozen flap valves in disconnected pre-1976 flow diversion structures, and protruding pipe stubs in manhole inverts, products of poor construction practice. In general, however, the storm drainage system appears to have been performing an adequate function as long as it operated inside the narrow limits of its design storm capacity. Problems would occur when this capacity would occasionally be exceeded by larger storms. There is no doubt that frequent capacity excesses have contributed to the premature aging of the system.

Soil subsidence and tidal flooding are non-design related system deficiencies which were also observed in our study. These two negative phenomena seem to feed on each other in specific low lying areas of the annex. In general minor tidal flooding in selected areas of the annex will occur when tides exceed the mean higher high tide elevation of 106.9 as the outfalls are ungated. Localized tidal flooding occurs rather frequently, sometimes more than once a day. This problem may have both dry and wet-weather variations. During a dry-weather day the site areas affected would be merely those of subtidal elevations, the area around the abandoned Gas Station at "I" and Manseau Streets being a good example. During wet-weather days, however, the problem compounds and extends to somewhat higher areas. High tides will have a backwater effect on flows in a sewer and will force the hydraulic gradient to rise above ground elevations with consequent flooding of the areas involved. These particular problems, while recurrent and bothersome, are not serious enough in themselves, however, to demand modifications of the system. The ultimate solution lies in raising subtidal grounds as part of the work to be done in the redevelopment phase of the Hunters Point Annex.

B. Environmental Aspects

The emphasis of this utility study, according to contract scope, is on hydraulic adequacy. Environmental adequacy of the storm sewerage system is addressed in a cursory manner only. With some exceptions, the system appears to be environmentally sound. The major upgrading steps to environmental soundness were taken in 1973 and 1976 when the sewer segregation projects, alluded to before, were implemented. Because there are still some live interconnections between both the storm and sanitary systems, these tend to interact from time to time with likely detrimental impact on the environment.

We have found indications of sanitary and industrial pollution throughout the storm sewer system. Sanitary pollution is believed to be minor and appears to be the exclusive result of leaks from the sanitary sewer system through infiltration and/or poorly disconnected pre-1976 flow diversion structures. We have found direct connections between both systems in at least two locations. In addition, the Phase 1 UTS Study documented one other direct connection. Industrial pollution, while not massive, does nevertheless occur in various parts of the system. For example, oil pollution appears to exist, the sources most likely being surface runoff of warehouse floor cleaning operations, and perhaps direct discharges into either sewers or manholes. As stated before, storm water quality investigation, and the whole matter of environmental soundness of the storm sewerage system, was not dealt with in any degree of specificity in this study. It has become apparent however from our observations in the field that some problems exist. Live interconnections with the sanitary sewer system have been addressed in the Sanitary Sewerage System Section. Industrial pollution concerns should be addressed by others.

C. Physical Condition

The existing storm sewer collection system condition varies from good to very poor. The following information was derived from field observations, discussions with Base personnel, review of existing documents and review and analysis of the gathered information. There are several key factors affecting the physical condition of the storm sewer collection system at the Hunters Point Annex. They are:

1. The age of the system.

2. The fact that most of the collection system has been built on apparently non-engineered fill and subject to differential settlement.

3. The fact that the existing storm sewer system at one time was a combined sanitary and storm system, subject therefore to very harsh treatment for many years.

4. The system has not been properly maintained and cleaned on a regular basis.

The overall condition of the existing storm sewer system built before 1958 can be described as poor. The storm sewers built as part of the 1973 project are in better condition but they appear to be limited in the storm water carrying capacity by several flow obstructing physical features observed during the field investigation. From the data observed during the video scanning of the sanitary sewers it can be assumed by association that broken joints, sags and debris exist in the storm sewer collection system as well. In the collection system there are many infiltration points, damaged manholes and construction deficiencies. The most significant finding from a functional point of view was that all the diversion structures observed have tide gates that are frozen in such a way that only a small amount of flow gets by. During heavy flows the water must go over an overflow weir on the barrier wall which supports the tide gate. This causes the solid material being carried by the storm sewer to settle out and collect in the storm sewer section upstream of the tide gate. These deposits will cause blockages and plugging of the storm sewer, and corrosive gas formation from decomposing organic debris as well. The area where the worst conditions exist is Area A (See Drawing SD-11) accentuated largely by ground settlement and the influence of frequent tidal action.

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NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

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VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 3.0 - INDEX

NETWORK ANALYSIS - EXISTING SYSTEM

3.0 EXISTING SYSTEM ANALYSIS

3.1 Purpose

Following is an analysis of the functional adequacy of the system in terms of its two most important vital characteristics, physical condition and hydraulic capacity. The findings of the analysis and the methods used in their derivation are discussed below. The purpose of this analysis is to determine the capacity of each system in terms of its storm frequency of design.

3.2 Hydraulic Analysis and Methodology

The methodology used for determining runoff for the ten systems analyzed is the Rational Method (DM 5.02-16). The Hazen-Williams formula was used for computation of friction losses as the systems were analyzed under pressure flow conditions (DM 5.03-13). Computations were done manually as no suitable computer program for pressure flow storm sewers was available. The following source data, coefficients and basic assumptions were used in the computations:

a. Rainfall Data: Rainfall Intensity-Duration-Frequency Curves for San Francisco, used for a 2 year storm analysis. Rainfall Intensity-Duration-Frequency Curves for Hunters Point as furnished by the U.S. Navy (Figure 6.2) used for the 5 year storm analysis.

b. Runoff Coefficient: A value of 0.8 was used throughout the analysis. It represents, in our opinion, the best composite value based on existing and future soil conditions at the Base, extent of roofed runoff and paved road surfaces and general drainage area topography.

c. Inlet Times: Ranging from 5 to 18 minutes, determined from Nomograph in Seelye's Design Manual for Engineers.

d. Friction Loss (Hl): A Hazen-Williams "C" value of 100 was used throughout the analysis for old and new pipe. This constitutes prudent and conservative design practice.

e. Transitions: Energy losses at flow transitions through manholes are accounted for by an allowance of 1/10 of a foot (0.1 Ft.) at each manhole or "network" node in the system (DM 5.03-15).

f. Energy Loss (Hv): Includes velocity head ($v^2/2g$) and the "transitions" loss components. The velocity head component may be zero if upstream pipe run had equal or higher velocity than pipe run under consideration.

g. Limiting Hydraulic Capacity: Both in the hydraulic analysis of the existing system components as well as for new elements in the improved system, this study considers that limiting hydraulic capacity is being reached when hydraulic grade line and ground elevations meet. The criterion is somewhat less restrictive than that prescribed by DM 5.03 which holds the hydraulic grade line elevation to 12 inches below inlet (or ground) elevation. The less restrictive criterion is proposed in this analysis because it is being applied to an existing system and because the potential for minor flooding which might result from the application of such criteria would not cause loss of facility. flooding (DM 5.03-3 & DM 5.03-23).

h. Backwater Design Elevation: Mean higher high tide elevation of 106.9 ft. Use of a lower tidal plane for design would be imprudent as it would exclude necessary safety margins for unforeseen wind effects on tidal movements and other tidal anomalies.

The results of the hydraulic analysis of the ten drainage systems are tabulated below. A discussion of these results follows.

EXISTING SYSTEMS

Drainage System (See Drawings SD-11 & SD-12)	Drainage Area Actual (Acres)	Effective (Acres)	Reference Table*	Limiting Capacity (Storm Frequency)
A	200	--	6.2	2 Years
B	51	--	6.3	2 Years
C	7	--	C	5 Years
D	35	--	6.5	2 Years
E	30	--	6.6	< 2 Years
F	17	29	6.7	2 Years
G	31	19	6.8	< 2 Years
H	33	--	H	5 Years
I	7	--	6.10	2 Years
J	7	--	J	5 Years
Total	418			

* See Appendix Part A

The standard for measuring the hydraulic adequacy of an existing storm drainage system is the design storm of specific frequency the system must be able to handle. Design Manual 5.03 establishes design frequencies for watersheds in terms of "Types of Facility" served and "Degree of Protection" necessary (DM 5.03-4 & DM 5.03-5). Minor systems, according to the Manual, are those which have watersheds of 100 acres or less or design runoff of 300 cfs or less (DM 5.03-3-1a). According to this definition, all ten systems analyzed fit the category of "minor systems". In such case, the recommended design frequency range for "permanent closed conduits" systems with adequate protection for "Local Roads and Streets" is 5 to 10 years. We have selected the 5 year storm frequency as "design frequency". It could be argued from an interpretation of the selection tables in the Manual that the 10 year frequency should perhaps have been adopted as design frequency. We would agree for the design of a new system. In this instance, however, if it were the case of an aging and underdesigned existing system, such selection would not be cost effective. The wisdom of a 5 year design frequency selection will become even more self-evident as hydraulic features of the existing and proposed systems are discussed immediately following.

With the 5-year design frequency as a standard, the hydraulic analysis found that the existing storm sewerage system has two major deficiencies:

1. The hydraulic capacity of the system as a whole is of substandard design. Only two minor systems, "C" and "J", representing just 3% of the total drainage area, tested positively for a 5 year storm. Six other systems tested positively for a 2 year storm, and two systems, "E" and "G" tested below 2 year storm adequacy.

2. The system as a whole, and the individual systems severally are hydraulically unbalanced. It is evident that non-uniform criteria was used in the design of the individual systems precluding their working together as a well integrated unit.

Following is a detailed discussion of major physical and hydraulic deficiencies of the ten drainage areas. Sewer runs are numbered, and in some cases letter-coded, for each drainage area and appear as such both on drawings SD-11 and SD-12 and in Tables 6.2 through 6.11.

Area A (Table 6.2)

This system is the largest of the ten minor drainage systems. It substantially covers what is generally known as the South Annex. The trunk sewers along "K", "R" and "I" Streets as well as the extension on Crisp Avenue, and the 72-inch outfall near Berth 37 were all part of the 1973 sewer separation project. The limiting capacity of the system is a 2-year storm. There are also internal imbalances in the system such that localized flooding may occur as a result of undersized sewers. The most critical area so affected is the 40-acre plot which extends 600 feet on each side of Mahan Street down from "J" Street up to the Regunning Pier. Specifically noteworthy of mention are:

- o Line 1.4 through 1.6 on Hussey Street between Mahan and Manseau Streets. These are old 15", 18" and 21" lines incorporated into the new 1973 trunk sewer system. They will flood the 8" drains from Building 307 to the Hussey Sewer.

- o Lines 21, 22 and 23 along lower "I" Street and southwesterly into "K" Street. This sewer section is undersized for a 2-year storm.

- o Line 221 at Manseau and "I" Street. The difficulty at this corner is low ground, possibly the result of soil subsidence. Eventual solution, raising of road and ground surfaces from lows of El. 107.5 to about El. 110.

- o Lines 2221, 2222 and 2223 on Hussey Street, between Manseau and Mahan. Old 15", 18" and 21" lines undersized for 2-year storm and will flood. These sewers are near the new SIMA Building. A 5-year storm, under current conditions, may cause flooding in areas adjacent to the SIMA Building. The ground floor of the SIMA Building at El. 110.67 could be in jeopardy of flooding with the existing storm sewer system.

- o Lines 1.21, 1.22 and 1.23 on "H" Street between Mahan and Manseau Streets. 18", 15" and 12" old sewers, are undersized, and complicated by low ground, will flood severely for a 2-year storm.

Area B (Table 6.3)

This area is a 51 acre drainage system, about half of it consisting of the hilltop housing area and the other half consisting of lower annex area running between Donahue and Coleman Streets northeasterly towards Dry Docks 5, 6 & 7. Housing area storm sewers are all new 1976 additions. The system will hydraulically accommodate a 2-year storm. However some storm drains in this area were found to have potential velocities in excess of 10 and 15 feet per second. DM 5.03 establishes maximum velocities of 15 feet per second in gravity systems and 10 fps in pressure systems. This is a "pressure flow" system and therefore the 10 fps maximum velocity should govern. Furthermore, as a rule, sewer hydraulics becomes imprecise at velocities in excess of 10 fps. Also, in this system there is a "decrease" in conduit size in the direction of flow, at a crucial point in the system; this is substandard practice (DM 5.03-23-2b). At this location (Table 6.2, Line 8) we found a sewer velocity of 20 fps for a 2-year storm. Drop-Manholes should have been used as a matter of standard sewerage practice to control erosive velocities (DM 5.8, Table 4).

Specific concerns are:

- Lines 7, 8 and 9 on Mc Cann Street. These are a 24" line laid at a 9% slope, a 15" line in the middle, laid at 16% slope and an upper 21" line laid at 2% slope. The corresponding flow velocities to a 2-year storm are 8.2 fps, 20 fps and 10 fps respectively. This is a "Venturi" tube-like situation, an ideal setting for flow cavitation, a potentially dangerous situation which can result in pipe rupture with street cave-in or wash-out damage.

- Lines 11, 12, 13 and 14 on Galvez Avenue and Donahue Street. These are 21", 18", 15" and 12" sewers laid at slopes up to 13.5%. Velocities range from 10 fps to 16 fps for the 2-year storm. Since pipes at these slopes have sufficient energy reserve to carry much larger flows, and in all likelihood are exposed to even greater velocities from time to time, the life of these sewers, can be expected to be quite short. The standard design practice for dissipating energy in steep slope sewer situations is the "drop-manhole" technique with connecting sewers at safe velocity slopes. This practice should be considered for future designs along steeply sloped streets.

- Line 4, a 33" sewer, has a flow diversion structure in front of Building 121 in which the overflow weir partition and flap gate are still intact. This condition is typical of pre 1973 sewer flow diversion structures in which these partitions should have been removed but were not. Such unremoved concrete partitions across the bottom of the flow-through chambers become dams which convert the upstream sewer into one long grit chamber.

Area "C" (Table C)

A small 7-acre area between Dry Dock 5 and Pier 129. This system is adequate for a 5-year storm.

Area "D" (Table 6.5)

A 35-acre area which takes in drainage from the steep hillside fronting Building 101 and drains downward to Berth 55. The system is adequate for a 2-year storm. The system is missing inlet and sewer facilities for the area in the vicinity of Bldg. 901.

Area "E" (Table 6.6)

This 30-acre area lying northwesterly of Berth 4 is generally adequate for a 2-year storm over 75% of its area. The remaining 25% of the area served by lines 31, 32, 33, and 34 on Spear Avenue and "C" Street is seriously underdesigned and will flood, even at a lesser than 2-year storm. The 12", 10", 6" and 4" sewers in the extremities of the subsystem are too small and substandard for their tributary areas.

Area "F" (Table 6.7)

This is a 17-acre area. In addition it also is picking up the overflow from some 12 acres from Area "G", therefore actually having an effective capacity of 29 acres. It is adequate for a 2-year storm. The area extends along Blandy Street from Spear Avenue down to Berth 5. It also includes sections of Van Keuren and Spear Avenues. The area is interconnected with Area "G" at a manhole at the intersection of Spear Avenue and Morell Street. Line 5 is the overflow line connecting both areas.

Area "G" (Table 6.8)

This is a 31 acre area. It incorporates the busily trafficked intersection of Fisher and Spear Avenues. The system by itself would have been scarcely adequate for a 1-year storm. However, with the 12 acre cross-over connection to Area "F" it is only about 40% area-effective for a 2-year storm. The other 60% of the area incorporates a substantial amount of hillside drainage generally collecting behind and on both sides of Building 813. The drainage from this area which is substantial, collects into the Spear Avenue sewer, halfway between "H" and Morell Streets. The sewer in this area can be expected to flood during lesser than 2 year storms. This system is overburdened and requires urgent relief.

Area "H" (Table H)

This is a 33-acre system draining essentially the area lying between Morell and Hussey Streets from south of Spear Avenue to south of Manseau Street. We found this to be the only hydraulically well balanced system. It discharges through a 42" outfall into Berth 15. The system is adequate for a 5-year storm.

Area "I" (Table 6.10)

This is a 7-acre system serving the "E" Street area from Morell Street down to Berths 10 and 13. It is adequate for a 2-year storm.

Area "J" (Table J)

This is a 7-acre system serving the western half of the Regunning Pier. It is adequate for a 5-year storm.

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VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 4.0 - INDEX

UTILITIES DEVELOPMENT PLAN

THROUGH FY1992

4.0 UTILITIES DEVELOPMENT PLAN THROUGH FY1992

4.1 Analysis and Evaluation

The Hunters Point Annex is a finite topographic are a unit which at the present time is not adequately drained by the existing storm sewer system. The annex has undergone many changes since its inception in the 1940's and is undoubtedly slated for more in the future, commencing with those for FY1992. Since storm sewers are not population but rather area-sensitive, it matters little what structures go up or down or what blocks are reconfigured in the life of a city like the Hunters Point Annex as long as they are being adequately conceived with some flexibility. In this vein, and in the broadest sense, we hold the proposed improvements to the existing storm sewer system not just as those required by today's annex but also as those sufficing for the infrastructure of the future Hunters Point Annex beyond FY1992.

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VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 5.0 - INDEX

NETWORK ANALYSIS - MASTER UTILITIES PLAN

5.0 NETWORK ANALYSIS - MASTER UTILITIES PLAN

5.1 General Discussion

The objective of proposed the improvements program is to correct the two major system deficiencies noted before, inadequate capacity and hydraulic imbalance, by providing:

1. Hydraulic capacity for a 5-year storm and

2. Hydraulic balance throughout the System

Essentially, this will be accomplished through two separate operations, a) redirection of drainage area runoffs and b) reinforcement of deficient sewer sections. The "Proposed Systems Guide" below summarizes key features of proposed changes to each of the ten subsystems.

PROPOSED SYSTEMS GUIDE

System (1)	Drainage Existing (Acres) (2)	Area Proposed (Acres) (3)	Hydraulic Improvements Dia.(in) (4)	L(ft) (5)	Capacity (Storm Frequency) (6)	Computation Tables (Refer to Appendix Part A) (7)
A	200	216	48-12	7,710	5-Year	A, A/H
B	51	51	30-18	1,700	5-Year	B
C	7	7	None	None	5-Year	C
D	35	34	21-10	2,335	5-Year	D
E	30	27	15-12	1,800	5-Year	E
F	17	20	15-12	590	5-Year	F
G	31	15	12	250	5-Year	G
H	33	33	18	200	5-Year	H
I	7	7	10	625	5-Year	I
J	7	7	None	None	5-Year	J
TOTAL	418	418		14,710		

COLUMN (7), "COMPUTATION TABLES TO BE FOUND IN THE APPENDIX, PART A, IDENTIFY THE RESPECTIVE COMPUTATION TABLES FOR EACH AREA. STORM SEWER ADDITIONS TO THE SYSTEM ARE ENTERED UNDER COLUMN (11a) IN THE TABLES. COLUMN (11c), IF USED, INDICATES COMBINED OLD AND NEW SEWER RUNS.

The Proposed additions to the storm drain system are shown on Drawings SD-13 & SD-14. The most significant redirection of runoff, 16 acres, will be from Area "G" to Area "A". On a smaller scale, 3 acres will go from Area "F" to Area "E". As may be seen, it will take approximately 3 miles of sewer reinforcements to bring the system up to a 5-year standard. Of this, half will be needed in Area "A" alone, mostly to cure the weakest of all systems, Area "G".

It is important to note that the proposed improvements program is fully compatible with the Navy's Master Plan for the future redevelopment of the Base. Furthermore, the program protects the environmental "status quo" of the Base by neither increasing nor decreasing the number of storm sewer outfalls currently in use. Also in conjunction with the future redevelopment of the base it is highly advisable that all subsided street surfaces be raised to a ground elevation of 110 to avoid tidal flooding in the future.

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UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 6.0 - INDEX

CONCLUSIONS & RECOMMENDATIONS

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions:

A. General

1. The storm sewerage system is of substandard capacity for a 5-year storm frequency. It is generally capable of a 2-year storm.

2. The storm sewerage system is hydraulically unbalanced, as a whole, and internally in its various systems.

3. There is tidal flooding due to street and/or ground surfaces with subtidal elevations.

4. There are permanent physical obstructions in manholes which interfere with free flow.

5. There are live interconnections with sanitary sewers which were not properly disconnected in the 1976 sewer separation project.

6. There is some industrial pollution which should be addressed by others.

7. The system is poorly maintained, as evidenced by large amounts of silt in manholes and catch basins.

In summary, the existing storm sewerage system is basically sound and can be upgraded to a 5-year design storm standard with a cost effective improvements program.

6.2 Recommendations

A. General

1. Implement a system upgrading program to conform it to a 5-year design storm standard. The necessary upgrading is described in the Specific Recommendation Section.

2. Provide for hydraulic balance.

3. Raise all street elevations in subsided areas to a minimum elevation of 110 feet. (See Drawing SD1 & SD2)

4. Implement a regular sewer maintenance program. The system including inlets, catch basins and manholes needs to be inventoried and subjected to a regular annual cleaning program.

5. Disconnect all improperly disconnected live sanitary

6. Industrial Waste Pollution needs to be addressed by others in future studies.

7. On future projects the use of drop-manholes should be used in accordance with the specifications of DM 5.8.

B. Specific System Improvements

See Drawings SD-3 & SD-4 "Storm Drain Systems - Future Conditions" section of proposed improvements. New sewer additions are specifically identified by their runs between manholes in the Tables pertaining to each area (for example, for Area B in Table B).

<u>Area "A" (Tables A & A/H, App. A)</u>

The most important improvement to the System occurs in this area with the proposed new "H" Street stormwater interceptor. The purpose of this interceptor is to redirect some 16 acres of Area "G" runoff into the Area "A" outfall. It is necessary, unfortunately, to take the new interceptor all the way down on "H" Street to within 575 feet of the 72-inch diameter outfall as there was no extra capacity available further upstream.

The sizing of the interceptor, from 48" diameter at the lower end to 24" at the upper, takes advantage of existing "H" Street sewers by working them into the system. In general, here as elsewhere throughout the System, where new sewers are proposed alongside existing ones, new and old sewers will flow into junction box-type manholes built around existing ones to assure that the combined capacity of new and old sewers is taken advantage of to the fullest.

Area "G", as discussed before, showed the greatest hydraulic deficiency in the analysis of the existing system. It contains the crucial Spear Avenue section from "H" Street to Drydock No. 4, which figures heavily in the development plans of the future Base. The area seems to have a long history of drainage difficulties as witnessed by the pressure of area overflows, plugged sewers, and street erosion. The "H" Street interceptor is designed to remove these problems from the future.

In addition, there will be some hydraulic reinforcing needed in the Bldg. 813 area. Also there will be some redirecting of Area "A" runoff from the existing "I" Street sewer into the new "H" Street interceptor by means of a new 24" connector (9H, Dwgs SD-13) in the Spear/Crisp Avenues intersection vicinity. The redirection of these 9 acres of runoff into the new "H" interceptor takes care of correcting the imbalance in these systems. In all, some 7,210 feet of sewers ranging in size from 12 to 48 inch diameter will be required for Area "A".

Area "B" (Table B, App. A)

The most significant addition in this area will be the proposed new 600 feet 30 inch diameter straight-line link on Donahue Street between upstream and downstream portions of the Area "B" system (3A-Dwg-13). This will do away with the substandardly high velocity conditions in sections of the system referred to before. In addition, reinforcements along upper Donahue Street will be required in order to control velocities and also to better facilitate the installation of hydraulically effective inlets in the future, particularly on streets in the housing area. A total of 1,700 feet of sewers ranging in size from 18 to 30 inches in diameter will be required in Area "B".

Area "C" (Table C, App. A)

This area needs no improvements.

Area "D" (Table D, App. A)

Reinforcing of some 625 feet of the main sewer immediately upstream of the Pier 132 outfall will be required (2, 3 & 4A - Drw-13). In addition, the Horne Avenue sewer is extended to the Bldg. 901 area to provide required drainage there. A total of 2,325 feet of new and reinforcing sewers ranging in size from 10 to 21 inch diameter will be required for Area "D".

Area "E" (Table E, App. A)

Approximately 1,800 feet of sewer reinforcements are required throughout this system, ranging in size from 12 to 15 inches in diameter. This area is being relieved of some 3 acres of runoff into Area "F". The new interconnecting sewer is being accounted for in Area "F" (3C-80-13).

Area "F" (Table F, App. A))

This area currently receives some 12 acres of runoff overflow from Area "G". Under the proposed improvements program it will no longer receive this overflow but will instead pick up some 3 acres of overflow from Area "E". A new 250 feet of 15" diameter area-connector sewer along Spear Avenue in the "C" Street vicinity will make this possible (3C-SD-13). Also proposed is a new straight line 12 inch diameter sewer connection (Line 32A) between existing manholes 7 & 9 in the Fisher and Van Keuren Avenues vicinity. In all, 590 feet of sewers ranging in size from 12 to 15 inches in diameter will be required in this area.

Area "G" (Table G, App. A)

This is currently the most overburdened drainage area. Our calculations indicated that under existing conditions, it overflows some 40% of its runoff into Area "F". Under the proposed improvements program, the new "H" Street interceptor will take about half of its 31 acre runoff. this will happen at Manhole 4G from where Line 5 (Drw-SD-13) will carry the overflow into the newly reinforced Area F system. Then, the existing sewer system, with minimal touch-up, will become self-sufficient for the first time. The one and important reinforcement being proposed is the 250 foot-12inch sewer from Spear Avenue along Cochrane Street (Line Sd-13) to relieve a drainage deficiency in the area behind Bldg. 302. This addition constitutes all that is needed for this area.

Area "H" (Table H, App. A)

This area checks out favorably for a 5-year storm. No additions are required.

Area "I" (Table I, App. A)

This area needs reinforcements on the upper reaches of the "E" Street sewer. A total of 625 feet of 10" diameter sewer reinforcements will be required for the area. It is to be noted that we are recommending 10 inch diameter sewer reinforcements, although the Manual prescribes 12 inch diameter sewers as a minimum. We are doing so, and only on a limited basis, because the 10-inch sewer is being added alongside existing sewers of larger diameters.

Area "J" (Table J, App. A)

This area checks out favorably for a 5-year storm. No additions are required.

In summary the cost of the proposed improvements to the storm drain system would cost approximately $3,780,000.

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UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM DRAIN SYSTEM

SECTION 7.0 - INDEX

RECOMMENDED PROJECTS FOR FULL MISSION

SUPPORT CAPABILITY

7.1 PROJECT REQUIREMENT:

To insure adequate storm drain system capacity and reliability for all existing and future demands through FY 1992.

7.2 RECOMMENDED MASTER UTILITY PLAN PROJECTS FOR FULL MISSION SUPPORT CAPABILITY TO FY 1992

MILCON PROJECT	FY FUNDING	PROJECT FUNDING $1,000'S	DESCRIPTION
MPM-SD	91	$3,780	Storm Drain System improvements, consisting primarily of new piping installation.

Refer to Drawings SD3 and SD4, Section 8.0, Part D for MPM-SD.

MILCON description follows in subsequent pages of this section. See Volume I, Executive Summary for completed D1391's, for Special Projects and Cost Estimates.

7.2 DISCUSSION:

The existing storm sewerage system is the result of an evolutionary process starting with the development of the annex in the 1940's. The system evidently grew in sections as dictated by the needs of the moment. This would explain the emergence of the ten independent drainage systems and the many minor drain systems in shoreline and pier areas which make up the existing overall drainage system. The improvements are necessary to meet the need of a five year storm, the current storm drain system can only handle a two year storm, in most areas of the station.

7.3 RECOMMENDATIONS:

A. General

1. Implement a system upgrading program to conform it to a 5-year design storm standard. The necessary upgrading is described in the Specific Recommendation Section.
2. Provide for hydraulic balance.
3. Raise all street elevations in subsided areas to a minimum elevation of 110 feet. (See Drawing SD1 & SD2)
4. Implement a regular sewer maintenance program. The system including inlets, catch basins and manholes needs to be inventoried and subjected to a regular annual cleaning program.
5. Disconnect all improperly disconnected live sanitary sewage interconnections.
6. Industrial Waste Pollution needs to be addressed by others in future studies.
7. On future projects the use of drop-manholes should be used in accordance with the specifications of DM 5.8.

CONTRACT NO. N62474-86-C-0969

UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 8.0 - INDEX

APPENDICES - PART A

TABLE 6.1

U T I L I T I E S   T E C H I N I C A L   S T U D Y,   P H A S E   II

HUNTER'S POINT ANNEX, SAN FRANCISCO, CALIFORNIA

STORM DRAINAGE SUBSYSTEMS
PHYSICAL CHARACTERISTICS

SUBSYSTEM	AREA (ACRES)	RUNOFF COEFF "C" (1)	TIME OF CONC. INLET MINIMUM (1)	TIME OF CONC. INLET MAXIMUM (1)	OUTFALL DIAMETER (INCHES)	TOTAL SEWERS (MILES)	SEWER DENSITY (MILES/ACRES)	LOW POINT ELEVATION
A	200	0.8	15	50	72	4.68	0.027	107.2
B	51	0.8	9	22	39	1.54	0.030	112.2
C	7	0.8	5	9	24	0.20	0.029	112.8
D	35	0.8	5	18	33	0.88	0.025	110.2
E	30	0.8	8	12	30	1.17	0.039	110.8
F	17	0.8	10	18	30	0.80	0.050	111.9
[illegible]	31	0.8	8	15	24	1.03	0.033	111.6
H	33	0.8	10	18	42	1.23	0.037	109.3
I	7	0.8	5	11	18	0.03	0.020	111.5
J	7	0.8	5	8	27	0.03	--	110.1
TOTAL	418							

(1) SOURCE: DATA BOOK FOR CIVIL ENGINEERS, VOL. 1, SEELYE

CONTRACT NO. N62474-86-C-0969

UTILITIES TECHNICAL STUDY, PHASE 2

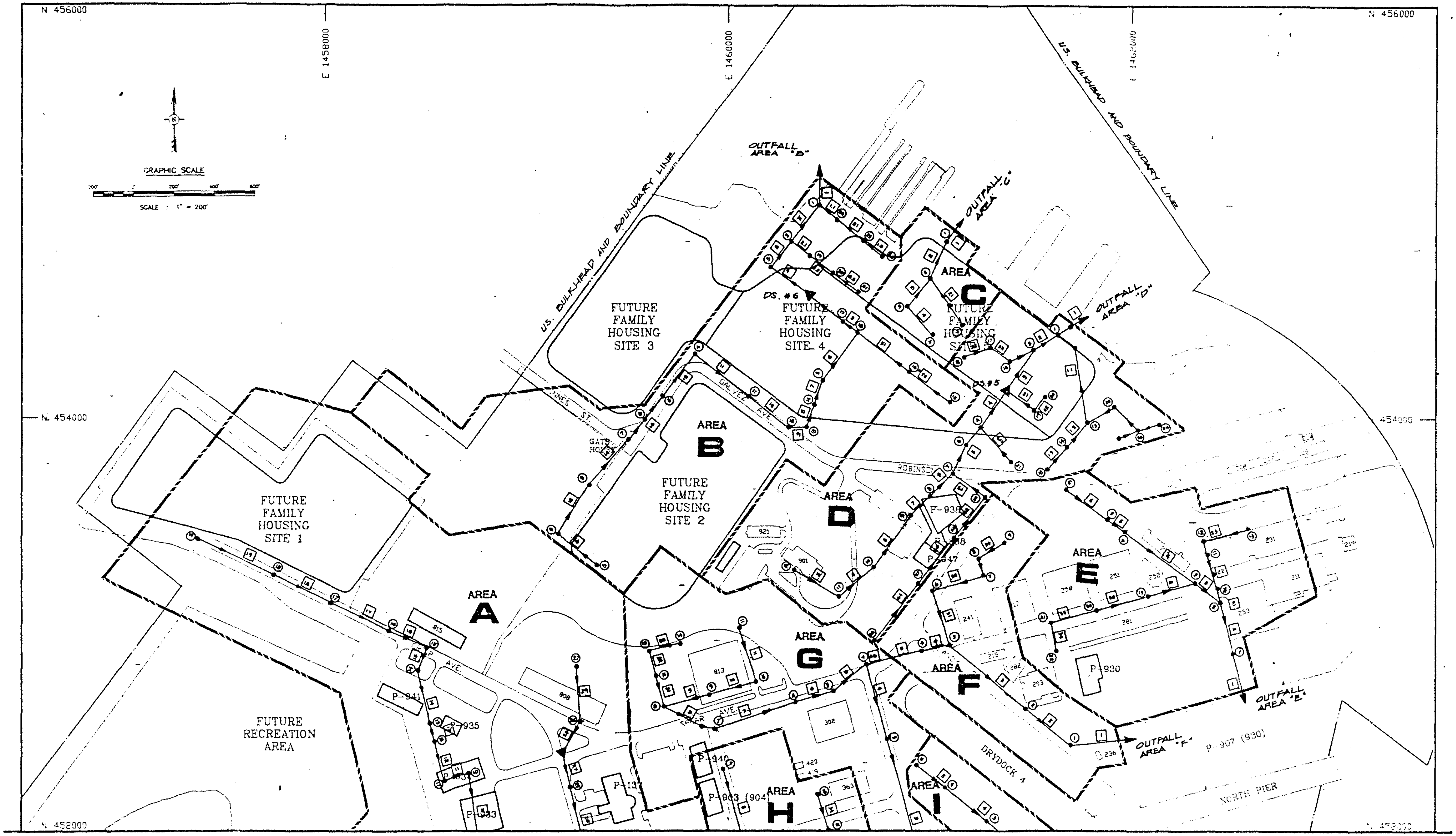
NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 8.0 - INDEX

APPENDICES - PART B



LEGEND

- MANHOLE NUMBER
- RUN NUMBER
- DIVERSION BOX
- DRAINAGE AREA.
- EXISTING STORM SEWER
- U.S. BULKHEAD AND BOUNDARY LINE.

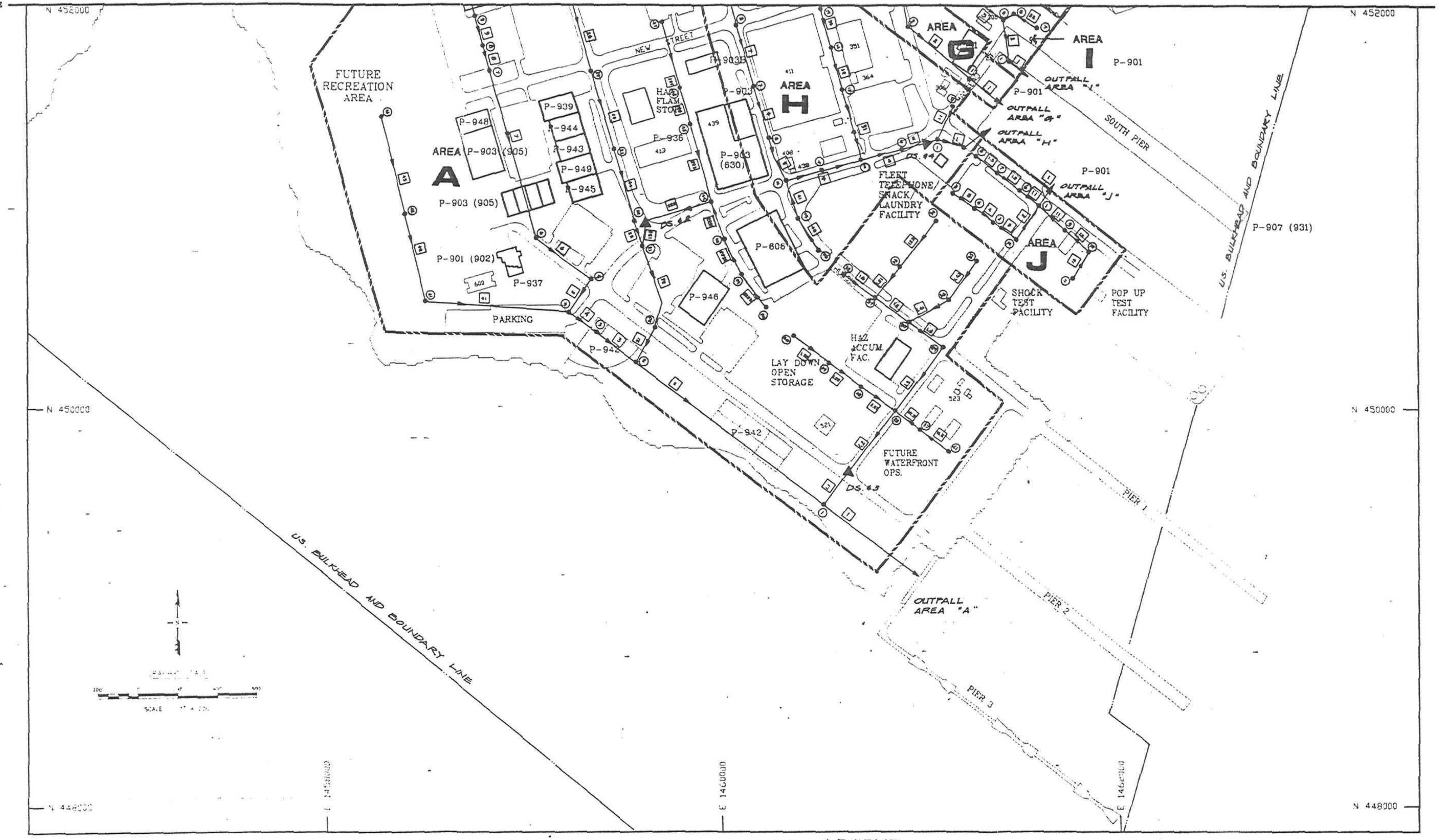
IF SHEET IS LESS THAN
28" X 40"
IT IS A REDUCED PRINT —
SCALE REDUCED ACCORDINGLY

SD-11

YEI ENGINEERS, INC.	DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND — WESTERN DIVISION — SAN BRUNO, CALIFORNIA
Villalobos & Associates, Consulting Engineers	NAVAL STATION, TREASURE ISLAND–HUNTERS POINT ANNEX, SAN FRANCISCO, CALIFORNIA
DR. MD / CHK. JLV	UTILITIES TECHNICAL STUDY, PHASE 2 NETWORK MODEL DIAGRAM / 1987 EXISTING CONDITIONS
SUBMITTED BY: DATE 12/8/88	SIZE F / CODE IDENT. NO. 80091
	SCALE NOTED

REVISIONS

SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED



LEGEND

- MANHOLE NUMBER
- RUN NUMBER
- DIVERSION BOX
- DRAINAGE AREA
- EXISTING STORM SEWER
- U.S. BULKHEAD AND BOUNDARY LINE

IF SHEET IS LESS THAN 28" X 40" IT IS A REDUCED PRINT — SCALE REDUCED ACCORDINGLY

SD-12

YEI ENGINEERS, INC.

Villalobos & Associates
Consulting Engineers

DSGN.	DR. MD	CHK. JLV
SUPV.		CH. ENGR.
SUBMITTED BY		DATE 12/8/88
E.I.C.		FIRE PROT.
BR. HD.		DIR.
SATISFACTORY TO		DATE
APPROVED		DATE

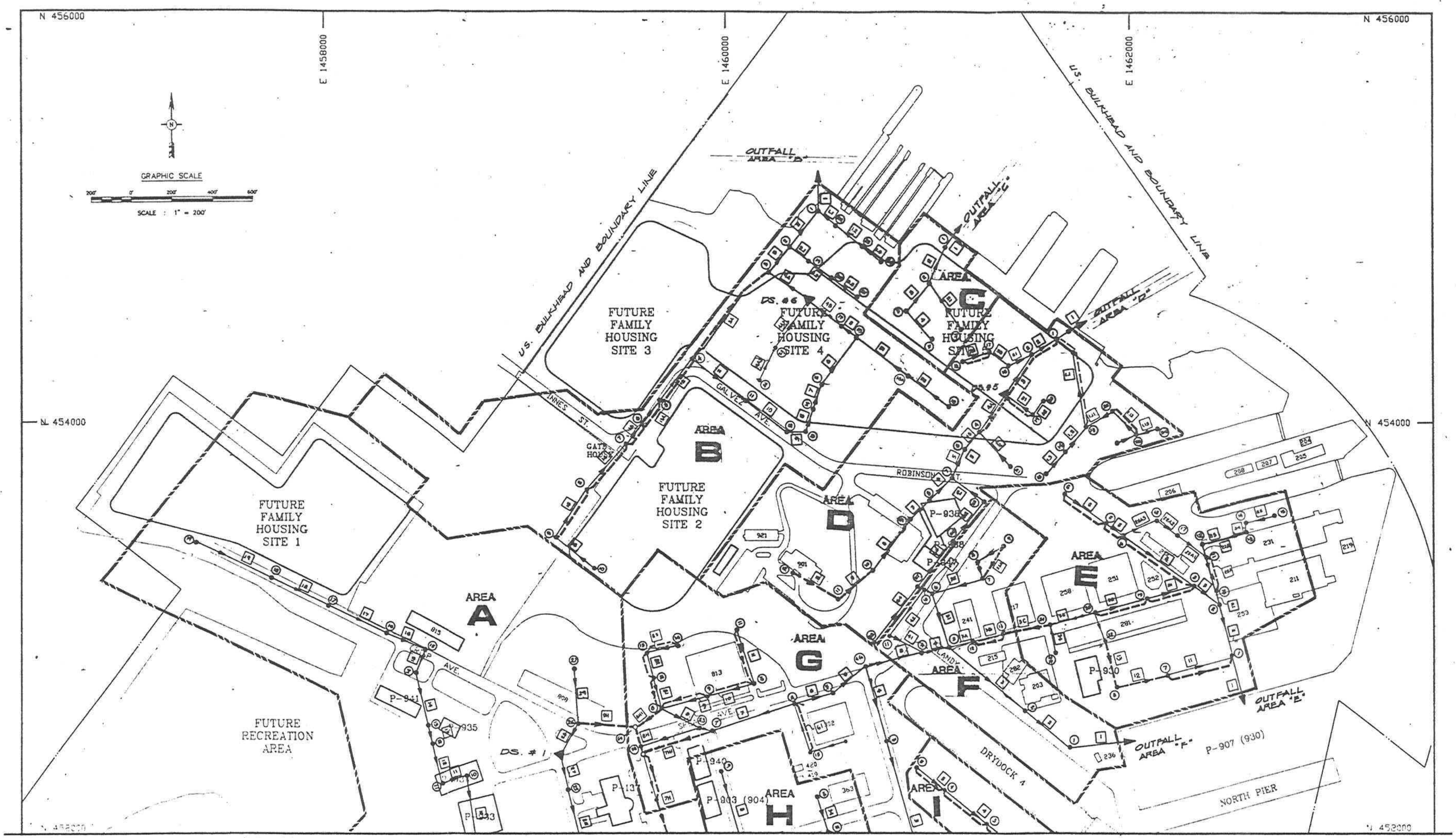
DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

NAVAL STATION, TREASURE ISLAND–HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

UTILITIES TECHNICAL STUDY, PHASE 2
NETWORK MODEL DIAGRAM
1987 EXISTING CONDITIONS

SIZE	CODE IDENT. NO.	NAVFAC DRAWING NO.
F	80091	
SCALE NOTED	SPEC.	SHEET OF

REVISIONS				
SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED



MATCH LINE

LEGEND

- ⑥ MANHOLE NUMBER
- ⑯ RUN NUMBER
- ▶ DIVERSION BOX
- DRAINAGE AREA
- EXISTING STORM SEWER
- PROPOSED ADDITION STORM SEWER
- U.S. BULKHEAD AND BOUNDARY LINE

IF SHEET IS LESS THAN 28" X 40" IT IS A REDUCED PRINT — SCALE REDUCED ACCORDINGLY

SD-13

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Consulting Engineers

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SUBMITTED BY		DATE 12/12/88
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BR. HD.	DIR.	
SATISFACTORY TO		DATE
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DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

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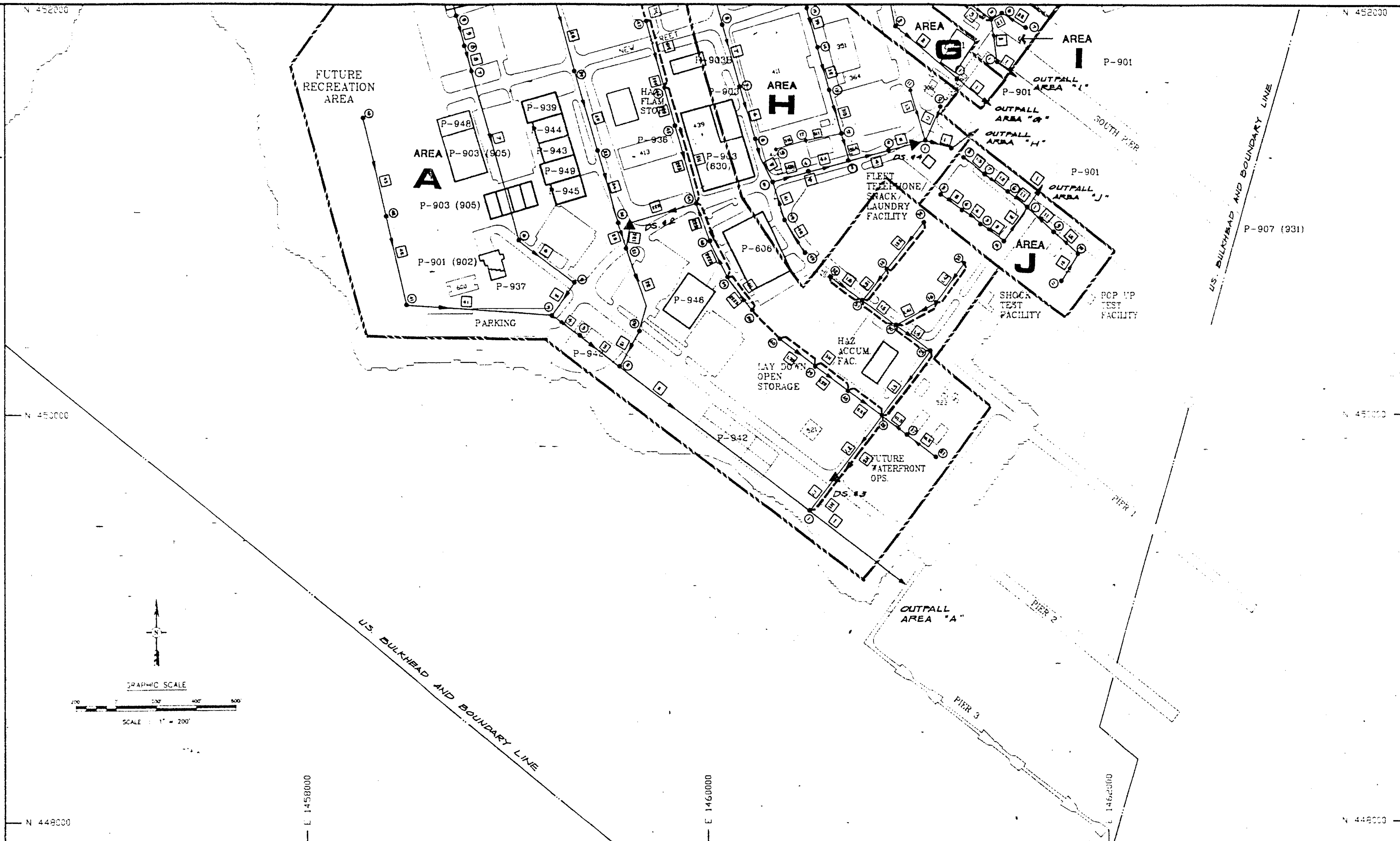
SAN FRANCISCO, CALIFORNIA

UTILITIES TECHNICAL STUDY, PHASE 2
NETWORK MODEL DIAGRAM
FUTURE CONDITIONS

SIZE	CODE IDENT. NO.	NAVFAC DRAWING NO.
F	80091	
SCALE NOTED	SPEC. —	SHEET OF

SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED
REVISIONS				

MATCH LINE



LEGEND

- MANHOLE NUMBER
- RUN NUMBER
- DIVERSION BOX
- DRAINAGE AREA
- EXISTING STORM SEWER
- PROPOSED ADDITION NEW STORM SEWER
- U.S. BULKHEAD & BOUNDARY LINE

IF SHEET IS LESS THAN 28" X 40"
IT IS A REDUCED PRINT —
SCALE REDUCED ACCORDINGLY

SD-14

YEI ENGINEERS, INC.

Villalobos & Associates
Consulting Engineers
3995 Smith Street Union City, CA 94587
Telephone (415) 489-9860

DSGN. | DR. MD | CHK. JVL
SUPV. | CH. ENGR.
SUBMITTED BY | DATE 12/2/88
E.I.C. | FIRE PROT.
BR. NO. | DIR.
SATISFACTORY TO | DATE
APPROVED | DATE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

NAVAL STATION, TREASURE ISLAND–HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

UTILITIES TECHNICAL STUDY, PHASE 2
NETWORK MODEL DIAGRAM
FUTURE CONDITIONS

SIZE F | CODE IDENT. NO. 80091 | NAVFAC DRAWING NO.
CONST. CONTR. NO.
SCALE NOTED | SPEC. | SHEET OF

UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 8.0 - INDEX

APPENDICES - PART C

PART C LIST OF COMPUTER ANALYSIS PRINTOUT REPORTS

Table No.	Description
6.2	Area A - 2 year storm
6.3	Area B - 2 year storm
6.4	Superseded by Table C
6.5	Area D - 2 year storm
6.6	Area E - 2 year storm
6.7	Area F - 2 year storm
6.8	Area G - 2 year storm
6.9	Superseded by Table H
6.10	Area I - 2 year storm
6.11	Superseded by Table J
A	Area A - 5 year storm
A/H	Area A - New H Interceptor - 5 year storm
B	Area B - 5 year storm
C	Area C - 5 year storm
D	Area D - 5 year storm
E	Area E - 5 year storm
F	Area F - 5 year storm
G	Area G - 5 year storm
H	Area H - 5 year storm
I	Area I - 5 year storm
J	Area J - 5 year storm

Note tables 6.2 through 6.11 are for existing conditions and tables A through J are for future conditions

TABLE 6.2

U T I L I T I E S   T E C H N I C A L   S T U D Y,   P H A S E   II

STORM DRAIN SYSTEM

2 YEAR STORM
AREA "A"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	TC (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	LOWER END	CROWN ELEVATION UPPER END	LOWER END	HYD. GRADIENTS UPPER END	LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	K STREET	1	OUTFALL		200.0	7.7 50.0	0.55	0.8	88	72		575.0	2.6	0.1	0.1	0.1	0.2	109.2				107.1	106.9
2	K STREET	1	2		160.0	1.6 42.4	0.60	0.8	76.8	72		117.5	2.7	0.1	0.1	0.2	0.3	110.0				107.4	
3		2	3		98.0	1.5 40.8	0.61	0.8	47.8	60		250.0	2.4	0.1	0.1	0.1	0.2	109.1				107.6	
4		3	4		96.0	1.3 39.3	0.62	0.8	47.6	60		175.0	2.4	0.1	0.1	0.1	0.2	111.1				107.8	
5		4	5		71.5	2.8 38.0	0.65	0.8	37.1	54		200.0	2.3	0.1	0.1	0.1	0.2	111.1				108.0	
6		5	6		69.0	6.2 35.2	0.70	0.8	38.6	54		425.0	2.4	0.1	0.1	0.1	0.2	111.1				108.2	
7		6	7		62.0	0.6 29.0	0.75	0.8	37.2	54		850.0	2.3	0.1	0.1	0.2	0.3	111.1				108.5	
8		7	8		55.0	0.8 28.4	0.80	0.8	35.2	48		125.0	2.8	0.1	0.1	0.1	0.2	111.1				108.7	
9		8	9		52.5	1.7 27.6	0.80	0.8	33.6	48		125.0	2.6	0.1	0.1	0.1	0.2	110.3				108.9	
10		9	10		50.0	0.4 25.9	0.81	0.8	32.4	48		250.0	2.6	0.1	0.1	0.1	0.2	111.1				109.1	
11		10	11		49.0	0.8 25.5	0.82	0.8	32.1	36		100.0	4.4	0.3	0.1	0.1	0.2	112.1				109.3	
12		11	12		46.0	0.4 20.7	0.82	0.8	30.1	36		200.0	4.2	0.3	0.1	0.2	0.3	113.1				109.6	
13		12	13		44.0	0.8 24.3	0.85	0.8	29.9	36		100.0	4.0	0.3	0.1	0.1	0.2	113.1				109.8	
14		13	14		39.5	0.4 23.5	0.85	0.8	26.9	30		260.0	5.4	0.5	0.1	0.5	0.6	115.0				110.4	
15		14	15		31.0	0.7 23.0	0.85	0.8	21.1	30		125.0	5.4	0.5	0.2	0.2	0.4	118.1				110.8	
16	CRISP	15	16		29.0	1.1 22.0	0.90	0.8	20.9	30		210.0	5.2	0.4	0.2	0.5	0.7	119.1				111.5	
17	CRISP	16	17		25.0	1.2 21.0	0.90	0.8	18.0	27		320.0	4.4	0.3	0.1	0.3	0.4	121.1				111.9	
18	CRISP	17	18		18.0	1.9 20.0	0.95	0.8	13.7	24		300.0	4.2	0.3	0.2	0.4	0.6	123.1				112.5	
19	CRISP	18	19		8.0	18.0	1.00	0.8	6.4	18		420.0	3.6	0.2	0.3	0.6	0.9	125.6				113.4	
1.1		1	DS3		39.0	1.2 15.5	1.10	0.8	34.3	30		200.0	7.0	0.8	0.4	0.6	1.0	110.4				108.1	107.1
1.2		DS3	28		30.0	1.2 14.3	1.15	0.8	27.6	30		410.0	5.5	0.5	0.1	0.8	0.9	110.1				109.0	
1.3		28	29		18.0	0.8 13.1	1.20	0.8	17.3	21		400.0	7.3	0.9	0.7	1.8	2.5	111.1				111.6 *	
1.4		29	30		10.0	1.0 12.3	1.30	0.8	10.4	21		200.0	4.4	0.3	0.2	0.4	0.6	110.9				112.2 *	
1.5		30	31		6.0	1.3 11.3	1.30	0.8	6.2	18		200.0	3.5	0.2	0.2	0.3	0.5	107.7				112.7 *	
1.6		31	32		2.5	10.0	1.40	0.8	2.8	15		175.0	2.3	0.1	0.2	0.1	0.3	107.7				113.0 *	

*Exceeds Ground Elevation

TABLE 6.2

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

2 YEAR STORM
AREA "A"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL		TC (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END	
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	
21		2	20		53.0	1.5	19.7	0.95	0.8	40.3	42		200.0	4.2	0.3	0.1	0.2	0.3	107.8				107.7		
22		20	21		49.0	0.6	18.2	1.00	0.8	39.2	42		425.0	4.0	0.3	0.3	0.4	0.7	107.5				108.4	107.4	
23		21	22		27.0	1.6	17.6	1.10	0.8	23.8	42		90.0	2.5	0.1	0.1	0.1	0.2	107.8				108.6		
24		22	23		25.5	1.8	16.0	1.10	0.8	22.4	33		400.0	3.7	0.2	0.1	0.3	0.4	109.1				109.0		
25		23	24		21.0	2.1	14.2	1.15	0.8	19.3	30		425.0	4.0	0.3	0.1	0.4	0.5	109.1				109.5		
26		24	25		16.0	0.8	12.1	1.30	0.8	16.6	27		520.0	4.2	0.3	0.1	0.7	0.8	111.6				110.3		
27		25	DS1		13.5	0.6	11.3	1.30	0.8	14.0	24		200.0	4.4	0.3	0.1	0.3	0.4	111.6				110.7		
28		DS1	26		9.0	0.7	10.7	1.35	0.8	9.7	18		200.0	5.4	0.5	0.2	0.7	0.9	111.8				111.6		
29		26	27		6.5		10.0	1.40	0.8	7.3	16		220.0	5.2	0.4	0.5	0.8	1.3	115.1				112.9		
41		4	41		22.5	3.3	16.3	1.10	0.8	18.0	36		700.0	3.1	0.2	0.2	0.4	0.6	112.0				108.4	107.8	
42		41	42		16.5	3.0	13.0	1.20	0.8	15.8	36		400.0	2.2	0.1	0.1	0.1	0.2	114.1				108.6		
43		42	43		9.5		10.0	1.40	0.8	10.6	24		570.0	3.2	0.2	0.3	0.5	0.8	113.0				109.4		
221		21	DS2		20.0	1.5	16.0	1.10	0.8	17.6	30		100.0	3.6	0.2	0.1	0.1	0.2	109.1				108.6	108.4	
222		DS2	44		19.5	1.9	14.4	1.15	0.8	18.0	30		350.0	3.6	0.2	0.1	0.3	0.4	111.0				109.0		SIMA 110.6
223		44	45		10.5	1.0	12.5	1.25	0.8	10.5	24		375.0	3.3	0.2	0.1	0.3	0.4	110.9				109.4		
224		45	46		8.0	1.5	11.5	1.30	0.8	8.3	21		200.0	3.5	0.2	0.1	0.2	0.3	110.4				109.7		
225		46	47		5.0		10.0	1.40	0.8	5.6	15		400.0	4.5	0.3	0.4	1.1	1.5	111.6				111.2		
2221		44	48		6.0	1.2	13.2	1.20	0.8	5.8	21		200.0	2.4	0.1	0.1	0.1	0.2	109.1				109.2	109.0	
2222		48	49		4.0	2.0	12.0	1.30	0.8	4.2	18		175.0	2.4	0.1	0.1	0.1	0.2	108.1				109.4		
2223		49	50		2.0		10.0	1.40	0.8	2.2	15		225.0	1.8	0.1	0.2	0.1	0.3	108.1				109.7		
1.21		28	38						0.8		18								107.1					110.1	
1.22		38	39																						
1.23		39	40																						

UTILITY TECHINICAL STUDY, PHASE II

SANITARY SEWER SYSTEM

TABLE 6.3

AREA "B"

LINE #	LOCATION	FROM STREET	TO STREET	AREA INCREMENT	(AC) TOTAL		Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	DONAHUE		OUTFALL	2.0	51.0	0.0	22.0	0.80	0.8	33.0	39		100	4.0	0.1	0.1	0.10	0.2		111.2			107.1	105.9
2	DONAHUE	BLDG #146		1.0	49.0	0.0	22.0	0.80	0.8	37.0	36		250	4.6	0.1	0.1	0.30	0.4					107.5	
3	DONAHUE	LOCKWOOD	BLDG #146	2.0	48.0	0.0	21.0	0.85	0.8	33.0	36		125	4.6	0.1	0.1	0.10	0.2					107.7	
4	LOCKWOOD	ENGLISH	DONAHUE	4.0	46.0	0.0	21.0	0.85	0.8	31.0	33		250	5.1	0.4	0.1	0.35	0.5					108.2	
5	LOCKWOOD	MC CAHN	ENGLISH	5.0	42.0	0.0	20.0	0.90	0.8	30.0	33		250	5.0	0.4	0.1	1.70	1.8	113.4				110.0	
6	MC CAHN	BLDG #115	LOCKWOOD	1.0	37.0	0.0	19.0	0.90	0.8	27.0	24		350	8.5	1.2	0.2	1.90	2.1	114.1	113.4			112.1	
7	MC CAHN	MH-51	BLDG. #115	2.0	36.0	0.0	19.0	0.90	0.8	26.0	24	0.090	100	8.2	1.1	0.1	0.90	1.0	123.1	114.1			113.1	
8	MC CAHN	MH-52	MH-51	0.0	34.0	0.0	19.0	0.90	0.8	24.5	15	0.160	100	20.0	6.4	4.9	4.50	9.4	139.1	123.1			122.5	
9	MC CAHN	GALVEZ	MH-52	2.0	34.0	0.0	19.0	0.90	0.8	24.5	21	0.020	100	10.0	1.6	0.8	0.90	1.7	141.1	139.1			124.2	
10	GALVEZ	ENGLISH	MC CAHN	2.0	32.0	0.0	18.5	0.95	0.8	24.0	24	0.010	300	7.5	0.9	0.1	1.30	1.9	144.1	141.1			125.6	
11	GALVEZ	DONAHUE	ENGLISH	1.0	30.0	0.0	18.0	1.00	0.8	24.0	21	0.013	325	10.0	1.6	0.1	2.60	2.7	148.3	144.1			128.3	
12	DONAHUE	HUDSON	GALVEZ	4.0	29.0	0.0	17.5	1.00	0.8	23.0	18	0.027	250	13.0	2.7	0.1	4.00	4.1	155.1	148.3			132.4	
13	DONAHUE	INNES	HUDSON	9.0	25.0	0.0	17.0	1.00	0.8	20.0	15	0.025	275	16.0	4.1	0.1	8.50	8.6	162.1	155.1			141.0	
14	DONAHUE	JERROLD	INNES	8.0	16.0	0.0	16.0	1.05	0.8	13.0	12	0.135	275	16.0	8.1	2.9	11.00	13.9	199.1	162.1			154.9	
15	DONAHUE	LORLWPPD	JERROLD	6.0	8.0	0.0	15.0	1.10	0.8	7.0	12	0.023	300	9.0	1.3	1.3	4.00	5.3	206.1	199.1			160.2	
16	KIRKWOOD	FRIDELL	DONAHUE	2.0	2.0	0.0	9.0	1.50	0.8	2.4	12	0.009	225	3.0	0.1	0.2	0.40	0.6	208.1	206.1	204		160.8	

TABLE 6.4

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

SUPERSEDED BY TABLE C
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TABLE 6.5

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

2 YEAR STORM
AREA "D"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2G	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	PIER 132	1	OUTFALL		35.0	17.5	1.00	0.8	28.0	33		100	5.0	0.4	0.2	0.1	0.3	113.5				107.2	106.9
2	BLDG #130	1	2		30.0	17.0	1.05	0.8	25.2	33		150	4.2	0.3	0.1	0.2	0.3	113.4				107.5	
3	BLDG #134	DS5	2		28.0	16.0	1.10	0.8	24.6	33		250	4.0	0.3	0.1	0.3	0.4	113.8				107.9	
4	BLDG #134	DS5	4		25.0	15.0	1.10	0.8	22.0	27		400	5.5	0.5	0.2	0.8	1.0	113.1				108.9	
5	ROBINSON	4	7		22.0	15.0	1.10	0.8	19.4	27		100	5.0	0.4	0.3	0.2	0.5	135.1				109.4	
6	RIBINSON	7	8		17.0	14.5	1.15	0.8	15.6	27		175	3.9	0.2	0.1	0.2	0.3	124.1				109.7	
7	HORNE	8	9		14.0	13.0	1.20	0.8	13.4	27		150	3.4	0.2	0.2	0.1	0.3	130.1				110.0	
8	HORNE	9	10		4.0	10.0	1.40	0.8	4.5	24		300	1.5	0.1	0.1	0.1	0.2	131.3				110.2	
11	PIER #132	1	13		6.0	12.0	1.30	0.8	6.2	15		475	5.0	0.4	0.4	1.6	2.0	111.7				109.2	107.2
12		13	14		3.0	11.0	1.30	0.8	3.1	15		100	2.5	0.1	0.1	0.1	0.2	111.4				109.4	
13	BLDG #135	14	15		2.0	10.0	1.40	0.8	2.2	10		200	4.0	0.3	0.1	0.7	0.8	116.1				110.2	
61		7	25		2.5	9.0	1.50	0.8	3.0	18		200	1.7	0.1	0.1	0.1	0.2	131.4				109.9	109.7
62		25	26		2.0	7.0	1.70	0.8	2.7	15		300	2.3	0.1	0.1	0.2	0.3	131.4				110.2	
63		27	26		1.5	6.5	1.90	0.8	2.2	12		250	2.8	0.1	0.1	0.4	0.5	131.4				110.7	
64		28	27		1.0	5.0	2.10	0.8	1.7	10		350	3.1	0.2	0.3	1.3	1.6	131.4				112.3	
111	BLDG 157	13	22		2.0	12.0	1.30	0.8	2.1	12		150	2.7	0.1	0.1	0.2	0.3	117.1				109.5	108.8
112		22	23		1.0	11.0	1.30	0.8	1.0	8		150	2.8	0.1	0.1	0.4	0.5	111.1				110.0	
113		23	24		0.5	10.0	1.40	0.8	0.6	8		125	1.7	0.1	0.2	0.1	0.3	112.1				110.3	

TABLE 6.6

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

2 YEAR STORM
AREA "E"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2G	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1	BERTH 3	1	OUTFALL		30.0	12.0	1.30	0.8	31.0	30		200	6.3	0.6	0.1	0.5	0.6	110.3	
2	LOCKWOOD	2	1		24.0	11.0	1.30	0.8	25.0	27		250	6.3	0.6	0.4	0.7	1.1	112.2	
3	LOCKWOOD	3	2		16.5	11.0	1.30	0.8	17.2	27		175	4.4	0.3	0.1	0.2	0.3	113.9	
4	LOCKWOOD	4	3		8.0	9.0	1.50	0.8	9.6	18		450	5.4	0.5	0.1	1.4	1.5	112.6	
5	LOCKWOOD	5	4		6.5	9.0	1.50	0.8	7.8	15		100	6.2	0.6	0.1	0.5	0.6	113.1	
6	LOCKWOOD	6	5		4.0	8.0	1.60	0.8	5.1	12		250	6.5	0.7	0.8	1.6	2.4	112.5	
31	SPEAR	3	19		7.5	10.5	1.35	0.8	8.1	12		225	10.2	1.8	0.3	4.5	4.8	113.1	
32	SPEAR	19	20		5.0	10.0	1.40	0.8	5.6	10		250	10.0	1.6	1.0	5.0	6.0	113.1	
33	SPEAR	20	21		3.0	9.0	1.50	0.8	3.6	10		250	6.5	0.7	0.7	2.2	2.9	113.4	
34	C STREET	21	22		1.0	8.0	1.60	0.8	1.3	10		150	2.4	0.1	0.2	0.2	0.4	111.7	
21	LOCKWOOD	2	10		6.5	10.0	1.40	0.8	7.3	18		75	4.0	0.3	0.2	0.2	0.4	112.6	
22	LOCKWOOD	10	12		3.5	9.0	1.50	0.8	4.2	15		250	3.4	0.2	0.1	0.4	0.5	112.0	
23	DRY DOCK 2	13	12		2.0	8.0	1.60	0.8	2.6	12		225	3.2	0.2	0.3	0.4	0.7	111.6	

TABLE 6.7

U T I L I T I E S   T E C H N I C A L   S T U D Y,   P H A S E   I I

STORM DESIGN SYSTEM

2 YEAR STORM
AREA "F"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	BERTH 5	1	OUTFALL		29.0	16.5	1.05	0.8	24.4	30		255	5.0	0.4	0.1	0.4	0.5	112.1				107.4	106.9
2	BLANDY	2	1		25.0	15.5	1.01	0.8	23.4	30		275	4.7	0.4	0.1	0.4	0.5	112.1				107.9	
3	BLANDY	3	2		24.0	14.0	1.20	0.8	23.0	27		500	5.7	0.5	0.3	1.1	1.4	112.0				109.3	
4	SPEAR	4	3		15.0	13.5	1.20	0.8	14.4	24		150	4.5	0.3	0.3	0.3	0.6	111.9				110.7	
5	SPEAR	46	4		16.0	12.0	1.30	0.8	12.5	24		300	3.9	0.2	0.2	0.4	0.7	112.1				110.5	
31	"D" STREET	6	3		6.0	12.0	1.30	0.8	6.2	18		300	3.6	0.2	0.1	0.4	0.5	113.0				109.8	109.3
32	VAN KEUREN	7	6		4.0	11.0	1.30	0.8	4.1	15		250	3.3	0.2	0.1	0.4	0.5	112.6				110.3	
33	PARKING LOT	9	7		2.0	10.0	1.40	0.8	2.2	10		250	4.0	0.3	0.4	0.9	1.3	112.6				111.6	

‡ FROM "G" STREET

TABLE 6.8

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

2 YEAR STORM
AREA "G"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	OUTFALL	1	OUTFALL		20.0	18.0	1.10	0.8	17.6	24		200	5.5	0.5	0.1	0.5	0.6	111.7				107.5	106.9
2	MOREEL	2	1		19.0	14.0	1.20	0.8	18.2	24		400	5.8	0.5	0.3	1.0	1.3	113.1				108.8	
3	MOREEL	3	2		15.0	13.0	1.20	0.8	14.4	24		550	4.5	0.3	0.1	0.8	0.9	112.6				109.7	
4	MOREEL	46	3		12.0	12.0	1.30	0.8	12.5	24		375	4.0	0.3	0.1	0.4	0.5	112.2				110.2	
5	SPEAR	5	46		21.0	11.5	1.30	0.8	21.8	21		200	9.0	1.3	0.2	1.4	1.6	111.6				111.8	
6	SPEAR	6	5		19.0	11.0	1.35	0.8	20.5	18		200	11.5	2.1	0.6	2.8	3.4	111.6				115.2 !	
7	SPEAR	7	6		16.0	10.0	1.40	0.8	17.9	18		400	10.0	1.6	0.1	4.0	4.1	111.6				119.3 !	
8	BLDG #813	8	7		14.0	10.0	1.40	0.8	15.7	15		250	12.8	2.6	1.9	4.5	6.4	112.8				125.7 !	
9	BLDG #813	9	8		6.0	6.5	1.80	0.8	8.6	15		240	7.0	0.8	0.1	1.5	1.6	112.8				127.3	
10	BLDG #813	10	9		5.0	6.0	1.90	0.8	7.6	12		220	9.5	1.5	1.0	3.6	4.6	112.8				131.9	
11	BLDG #813	11	10		3.0	5.0	2.00	0.8	4.8	12		300	6.0	0.6	0.7	1.9	2.6	113.4				134.5	
81	W OF #813	12	8		3.0	9.0	1.50	0.8	9.6	15		150	7.7	1.0	0.2	1.2	1.4	115.4				127.1	125.7
82	W OF #813	13	12		5.0	8.5	1.50	0.8	6.0	12		125	7.5	0.9	0.2	1.2	1.4	115.4				128.5	
83	BLDG #813	14	13		3.0	8.0	1.60	0.8	3.8	10		150	7.0	0.8	0.9	1.5	2.4	115.4				130.9	

! Will Flood Gradient
have no significanc
beyond this point?

TABLE 6.9

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

SUPERSEDED BY TABLE H
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TABLE 6.10

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

2 YEAR STORM
AREA "I"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL		TC (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1	BERTH 13	1	OUTFALL	0.8	7.0	0.9	11.0	1.35	0.8	7.6	18		75	4.3	0.3	0.2	0.2	0.4	112.1				107.3	106.9
2	MANSEAU	2	1	2.5	6.2	0.6	9.8	1.40	0.8	6.9	18		200	3.8	0.2	0.1	0.3	0.4	111.9				107.7	
3	"E" STREET	3	2	1.5	3.7	1.0	9.2	1.45	0.8	4.3	12		200	5.4	0.5	0.4	1.0	1.4	111.6				109.1	
4	"E" STREET	4	3	0.7	2.2	0.6	8.2	1.55	0.8	2.7	12		225	3.5	0.2	0.1	0.5	0.6	111.5				109.7	
5	"E" STREET	5	4	0.8	1.5	0.5	7.5	1.60	0.8	1.9	10		200	3.5	0.2	0.2	0.6	0.8	111.6				110.5	
21	BERTH 10	2	6	0.5	1.5	1.0	6.0	1.90	0.0	2.3	12		50	2.9	0.1	0.1	0.1	0.2	112.1				107.9	107.7
22		6	7	0.0	1.0	0.0	5.0	2.00	0.8	1.6	10		125	2.9	0.1	0.2	0.3	0.5	112.1				108.4	

TABLE 6.11

UTILITIES TECHNICAL STUDY, PHASE II

STORM DRAIN SYSTEM

SUPERSEDED BY TABLE J
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TABLE A

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

5 YEAR STORM

AREA "A"

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	LOWER END	CROWN ELEVATION UPPER END	LOWER END	HYD. GRADIENTS UPPER END	LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL	88.0	216.0	40.0	0.90	0.8	157.7		72			575	5.4	0.5	0.4	0.4	0.8	109.2				107.7	106.9
2		2	1	30.0	128.0	34.0	1.00	0.8	104.8		72			1200	3.8	0.2	0.1	0.4	0.5	110.0				108.2	
3		3	2	2.0	98.0	33.0	1.00	0.8	78.4		60			225	3.9	0.2	0.1	0.1	0.2	109.1				108.4	
4		4	3	24.5	96.0	32.2	1.05	0.8	80.1		60			200	4.1	0.3	0.2	0.1	0.3	111.1				108.7	
5		5	4	2.5	71.5	31.3	1.05	0.8	60.1		54			200	3.8	0.2	0.1	0.1	0.2	108.5				108.9	
6		6	5	7.0	69.0	29.5	1.10	0.8	60.7		54			400	3.8	0.2	0.1	0.2	0.3	111.1				109.2	
7		7	6	7.0	62.0	25.5	1.20	0.8	59.5		54			850	3.6	0.2	0.1	0.4	0.5	111.1				109.7	
8		8	7	2.5	55.0	25.1	1.20	0.8	52.8		48			100	4.2	0.3	0.1	0.1	0.2	111.1				109.9	
9		9	8	2.5	52.5	24.6	1.20	0.8	50.4		48			125	4.0	0.3	0.2	0.1	0.3	110.3				110.2	
10		10	9	1.0	50.0	23.4	1.20	0.8	48.0		48			250	3.8	0.2	0.1	0.1	0.2	111.1				110.4	
11		11	10	3.0	49.0	23.1	1.25	0.8	49.0		36			100	6.8	0.8	0.2	0.2	0.4	112.1				110.8	
12		12	11	2.0	46.0	22.6	1.25	0.8	46.0		36			200	6.4	0.7	0.2	0.4	0.6	113.1				111.4	
13		13	12	4.5	44.0	22.3	1.25	0.8	44.0		36			100	6.2	0.6	0.1	0.2	0.3	113.1				111.7	
14		14	13	8.5	39.5	21.8	1.25	0.8	39.5		30			260	8.0	1.0	0.4	1.0	1.4	115.1				113.1	
15		15	14	2.0	31.0	21.5	1.30	0.8	32.2		30			125	6.5	0.7	0.2	0.3	0.5	118.1				113.6	
16		16	15	4.0	29.0	20.9	1.30	0.8	30.2		30			210	6.2	0.6	0.1	0.5	0.6	119.1				114.2	
17		17	16	7.0	25.0	20.2	1.35	0.8	27.0		27			300	7.0	0.8	0.3	1.0	1.3	121.1				115.5	
18		18	17	10.0	18.0	19.4	1.35	0.8	19.4		24			300	6.0	0.6	0.3	0.8	1.1	123.1				116.6	
19		19	18		8.0	18	1.40	0.8	9.0		18			420	5.0	0.4	0.5	1.2	1.7	125.1				118.3	
																								118.3	
21		20	2	2.0	24.0	19.2	1.35	0.8	25.9		42			200	2.7	0.1	0.1	0.1	0.2	107.6				108.4	108.2
22		21	20	3.0	22.0	16.4	1.40	0.8	24.6		42			425	2.5	0.1	0.1	0.1	0.2	107.8				108.6	
23		22	21	1.5	19.0	15.7	1.45	0.8	22.0		42			100	2.3	0.1	0.1	0.1	0.2	107.9				108.8	
24		23	22	4.5	17.5	13.9	1.60	0.8	22.4		33			400	3.8	0.2	0.1	0.3	0.4	109.1				109.2	
25		24	23	5.0	13.0	12.0	1.75	0.8	18.2		30			425	3.7	0.2	0.1	0.4	0.5	110.4				109.7	
26		25	24	2.5	8.0	9.2	1.90	0.8	12.2		27			520	3.1	0.2	0.1	0.4	0.5	111.6				110.2	
27		DS1	25	4.5	5.5	8.0	1.95	0.8	8.6		24			200	2.7	0.1	0.1	0.1	0.2	111.8				110.4	
28		26	DS1		1.0	5.0	2.30	0.8	1.8		18			200	1.1	0.1	0.1	0.1	0.2	113.1				110.6	

29 Flows into new 9H Storm Sewer

TABLE A/H

U T I L I T I E S T E C H N I C A L S T U D Y , P H A S E I I

STORM SEWER SYSTEM

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

5 YEAR STORM
NEW H STREET INTERCEPTOR
AREA "A"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MN)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	LOWER END	CROWN ELEVATION UPPER END	LOWER END	HYD. GRADIENTS UPPER END	LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1H		DS3	1		88.0	25.5	1.20	0.8	84.5	48	30	56.6		200	4.3	0.3	0.2	0.10	0.3	110.4				108.0	107.7
2H		28	DS3		79.0	24.6	1.20	0.8	75.8	48	30	56.6		375	4.1	0.3	0.1	0.20	0.3	110.6				108.3	
3H		40	28		55.0	22.0	1.30	0.8	57.2	48	(15,18,21)	51.3		600	3.9	0.2	0.1	0.30	0.4	109.8				108.7	
4H		44	40		47.5	18.5	1.40	0.8	53.2	48	(15,18,21)	50.5		800	3.8	0.2	0.1	0.40	0.5	111.1				109.2	
5H		45	44		38.5	17.0	1.50	0.8	46.2	42	24	48.5		400	3.6	0.2	0.1	0.20	0.3	110.8				109.5	
6H		47	45		33.0	14.6	1.60	0.8	42.2	42	(15,18,21)	45.8		550	3.8	0.2	0.1	0.30	0.4	111.6				109.9	
7H		52	47		29.0	12.6	1.70	0.8	39.4	42	10	43.3		450	3.8	0.2	0.1	0.30	0.4	118.8				110.3	
8H		54	52		19.0	12.2	1.75	0.8	26.6	36				100	3.8	0.2	0.1	0.10	0.2	113.1				110.5	
9H		26	54		9.0	11.0	1.80	0.8	13.0	24				300	4.4	0.3	0.4	0.40	0.8	115.1				111.3	
7H1		7	52		8.0	10.0	1.85	0.8	11.8	24	18	30		350	2.3	0.1	0.2	0.10	0.3	111.6				110.6	110.3
8H1		8	54		10.0	10.0	1.85	0.8	14.8	27				150	3.6	0.2	0.3	0.10	0.4	112.8				110.9	110.5
1.3		29	28		15.0	11.5	1.75	0.8	21.0	24	21	31.9		400	3.8	0.2	0.1	0.30	0.4	111.1				108.7	108.3
1.4		30	29		11.9	10.7	1.80	0.8	17.1	18	21	27.7		200	4.1	0.3	0.2	0.20	0.4	110.9				109.1	
1.5		31	30		7.6	9.6	1.85	0.8	11.2	18	18	25.5		200	3.1	0.2	0.2	0.20	0.4	107.7				109.5	
1.6		32	31		1.2	7.5	2.00	0.8	1.9		15			200	1.5	0.1	0.2	0.10	0.3	107.7				109.8	
1.51		33	31		5.2	9.5	1.85	0.8	7.7	18	8	19.7		200	3.7	0.2	0.2	0.3	0.5	109.2				110.0	109.5
1.52		34	33		2.5	7.5	2.00	0.8	4.0	15	8	17		300	2.5	0.1	0.2	0.2	0.4	109.6				110.4	
1.41		36	30		3.1	6.4	2.10	0.8	5.2	15	10	18		225	2.9	0.1	0.1	0.2	0.3	107.0				109.4	109.1
1.42		35	36		1.7	5.0	2.3	0.8	3.1	12	8	14.4		225	2.7	0.1	0.2	0.3	0.5	108.0				109.9	
(FROM AREA G)																									
9		9	8		5.0	8.3	1.95	0.8	7.8	12	15	19.2		240	3.8	0.2	0.1	0.4	0.5	112.8				111.4	110.9
10		10	9		4.0	7.4	2.00	0.8	6.4	12	12	17		220	4.0	0.3	0.3	0.4	0.7	112.8				112.1	
11		11	10		2.0	5.0	2.30	0.8	3.7	12	12	17		300	2.3	0.1	0.2	0.2	0.4	113.4				112.5	
(FROM AREA G)																									
81		12	8		5.0	9.4	1.85	0.8	7.4	12	15	19.2		150	3.6	0.2	0.1	0.2	0.3	115.4				111.2	110.9
82		13	12		4.0	8.9	1.90	0.8	6.1	12	12	17		125	3.8	0.2	0.2	0.2	0.4	115.4				111.6	
83		14	13		2.5	8.0	1.95	0.8	3.9	12	10	15.6		150	2.9	0.1	0.2	0.2	0.4	115.4				112.0	

TABLE B

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

LEGEND
11a - New and/or Reinforc[illegible] Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

5 YEAR STORM

AREA "B"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		51.0	18.3	1.40	0.8	57.1		39			100	7.0	0.8	0.1	0.20	0.3	111.2				107.2	106.9
2		2	1		48.5	17.8	1.45	0.8	56.3		36			250	7.9	1.0	0.2	0.80	1.0	113.1				108.2	
3		3	2		46.6	17.5	1.45	0.8	53.9		36			125	7.5	0.9	0.2	0.30	0.5	113.6				108.7	
3A		4	3		25.0	12.9	1.70	0.8	34.0	30			0.051	600	7.0	0.8	0.4	1.70	2.1	144.1				110.8	
12		5	4		28.0	12.2	1.75	0.8	39.2	30	18	35		250	5.8	0.5	0.1	0.40	0.5	148.3				111.3	
13A		6	5		25.5	11.8	1.80	0.8	36.7	30	15	33.5		140	6.0	0.6	0.2	0.30	0.5	159.1				111.8	
13B		7	6		19.5	11.4	1.80	0.8	28.1	24	15	30		135	5.7	0.5	0.1	0.30	0.4	162.1				112.2	
14		8	7		15.0	10.5	1.90	0.8	22.8	24	12	26.8		300	5.7	0.5	0.2	0.70	0.9	199.1				113.1	
15		9	8		8.0	9.6	2.00	0.8	12.8	18	12	21.6		275	5.0	0.4	0.1	0.60	0.7	206.1				113.8	
16		10	9		1.5	9.0	1.90	0.8	2.3		8			250	6.5	0.7	0.8	3.00	3.8	208.1				117.6	
4A		DS6	3		19.0	21.0	1.30	0.8	19.8		33			250	3.2	0.2	0.2	0.20	0.4	113.4				108.9	108.5
4B		17	DS6		15.0	19.8	1.40	0.8	16.8		33			200	2.7	0.1	0.1	0.10	0.2	113.6				109.1	
5		16	17		14.5	19.5	1.40	0.8	16.2		24			100	5.1	0.4	0.3	0.20	0.5	113.4				109.6	
6		5	16		10.5	18.1	1.45	0.8	11.8		24			300	3.7	0.2	0.1	0.40	0.5	114.1				110.1	
7		14	5		8.5	17.2	1.45	0.8	9.9		24			175	3.2	0.2	0.1	0.10	0.2	123.1				110.3	
8		13	14		7.0	17.0	1.45	0.8	8.1		15		0.16	60	6.6	0.7	0.6	0.40	1.0	139.1				111.3	
9		12	13		7.0	16.6	1.50	0.8	8.4		21			75	3.4	0.2	0.1	0.10	0.2	141.1				111.5	
10		11	12		6.0	15.0	1.60	0.8	7.7		21			300	3.2	0.2	0.2	0.3	0.5	144.1				112.0	
11		4	11		4.5	13.0	1.70	0.8	6.1		21			300	2.5	0.1	0.2	0.2	0.4	148.3				112.4	
1.1		22	1		2.0	7.1	2.05	0.8	3.3		18			125	1.8	0.1	0.1	0.1	0.2	112.6				107.4	107.2
1.2		23	22		1.5	6.1	2.15	0.8	2.6		15			125	2.2	0.1	0.1	0.1	0.2	112.2				107.6	
1.3		24	23		1.0	5.0	2.3	0.8	1.8		12			150	2.3	0.1	0.2	0.2	0.4	112.1				108.0	
2.1		19	2		1.5	8.7	1.95	0.8	2.3		15			125	1.8	0.1	0.2	0.1	0.3	113.1				108.5	108.2
2.2		20	19		1.0	7.1	2.05	0.8	1.6		15			125	1.3	0	0.1	0.1	0.2	113.1				108.7	
2.3		21	20		0.5	5.0	2.30	0.8	0.9		12			150	1.2	0	0.1	0.1	0.2	113.1				108.9	
4A1		25	DS6		2.5	5.4	2.20	0.8	4.4		15			300	3.6	0.2	0.1	0.5	0.6	113.7				109.5	108.9
4A2		26	25		1.0	5.0	2.30	0.8	1.8		10			75	3.3	0.2	0.3	0.2	0.5	115.1				110.0	
51		16A	16		2.5	14.0	1.50	0.8	3.0		(18+10)	20.6		330	1.3	0	0.1	0.1	0.2	113.1				109.8	109.6
52		18	16A		0.5	5	2.3	0.8	0.9		(18+10)	20.6		220	0.4	0	0.1	0.1	0.2	113.5				110.0	

TABLE C

U T I L I T I E S   T E C H N I C A L   S T U D Y ,   P H A S E   I I

STORM DRAIN SYSTEM

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

5 YEAR STORM
AREA "C"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL		Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2G	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		7.0	1.0	9.0	2.10	0.8	11.8	24		50	3.8	0.2	0.2	0.1	0.3	112.1				107.2	106.9
2		1	2		4.5	2.0	8.0	2.20	0.8	7.9	24		200	2.5	0.1	0.1	0.1	0.2	113.4				107.4	
3		2	3		1.6	1.0	6.0	2.50	0.8	3.2	18		155	1.8	0.1	0.1	0.1	0.2	113.1				107.6	
4		3	4		0.9	0.0	5.0	2.70	0.8	1.9	10		200	3.5	0.2	0.3	0.6	0.9	113.4				108.5	
21		2	5		0.9	0.0	5.0	2.70	0.8	1.9	8		250	2.4	0.1	0.2	0.3	0.5	113.4		113		107.9	107.4

TABLE D

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

5 YEAR STORM

AREA "D"

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of
Pressure Flow Analysis

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MN)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	LOWER END	CROWN ELEVATION UPPER END	LOWER END	HYD. GRADIENTS UPPER END	LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		34.0	15.4	1.55	0.8	42.2		33			100	7.0	0.8	0.6	0.3	0.9	113.5				107.8	106.9
2		2	1		29.0	14.8	1.60	0.8	37.1	21	33	39.1		150	4.4	0.3	0.1	0.1	0.2	113.4				108.0	
3		DSS	2		26.0	13.8	1.65	0.8	34.3	21	33	39.1		250	4.1	0.3	0.1	0.2	0.3	113.8				108.3	
4A		4	DSS		23.5	13.0	1.70	0.8	32.0	21	27	34.2		225	4.9	0.4	0.1	0.3	0.4	113.1				108.7	
4B		6	4		21.5	12.3	1.70	0.8	29.2		27			175	7.4	0.9	0.3	0.5	0.8	113.1				109.5	
5		7	6		20.0	11.9	1.70	0.8	27.2		27			100	6.8	0.7	0.1	0.3	0.4	135.1				109.9	
6		8	7		18.5	11.4	1.75	0.8	25.9		27			150	6.4	0.7	0.4	0.4	0.8	127.1				110.7	
7		9	8		13.5	11.6	1.80	0.8	19.4		27			150	4.8	0.4	0.3	0.3	0.6	130.1				111.3	
8		10	9		7.0	10.1	1.85	0.8	10.4		24			300	3.3	0.2	0.1	0.3	0.4	131.3				111.7	
9		11	10		3.5	8.8	1.90	0.8	5.3	15				350	4.4	0.3	0.1	0.9	1.0	193.1				112.7	
10		12	11		2.5	7.5	2.00	0.8	4.0	12				400	5.0	0.4	0.5	1.9	2.4	210.1				115.1	
1.1		13	1		4.0	6.8	2.05	0.8	6.6	15	15	21.2		475	2.7	0.1	0.1	0.3	0.4	113.5				108.2	107.8
1.2		14	13		1.5	6.0	2.20	0.8	2.6		15			100	2.1	0.1	0.1	0.1	0.2	111.7				108.4	
1.3		15	14		1.0	5.0	2.30	0.8	1.8		10			200	3.3	0.2	0.3	0.5	0.8	115.1				109.2	
21		16	2		1.5	9.8	1.85	0.8	2.2		15			125	1.8	0.1	0.1	0.1	0.2	112.5				108.2	108.0
22		17	16		1.5	9.2	1.90	0.8	2.3		12			100	2.9	0.1	0.1	0.2	0.3	113.1				108.5	
23		18	17		1.0	7.5	2.00	0.8	1.6	10	8	13.8		150	1.5	0.1	0.2	0.1	0.3	113.4				108.8	
31		19	DSS		1.0	8.0	1.95	0.8	1.6	10	8	13.8		160	1.5	0.1	0.1	0.1	0.2	113.5				108.5	108.3
32		20	19		0.5	7.5	2.00	0.8	0.8		8			75	2.3	0.1	0.2	0.2	0.4	113.5				108.9	
4A1		21	4		1.0	5.0	2.30	0.8	1.8		10			225	3.3	0.2	0.3	0.6	0.9	119.1				109.6	108.7
61		25	7		3.0	9.7	1.90	0.8	4.6		18			200	2.5	0.1	0.1	0.2	0.3	131.4				111.0	110.7
62		26	25		2.5	8.1	2.00	0.8	4.0		15			300	3.2	0.2	0.1	0.5	0.6	131.4				111.6	
63		27	26		1.5	6.8	2.10	0.8	2.5		12			250	3.2	0.2	0.1	0.5	0.6	131.4				112.2	
64		28	27		1.0	5.0	2.30	0.8	1.8		10			350	3.2	0.2	0.3	0.8	1.1	131.4				113.3	
1.11		22	13		1.5	7.4	2.00	0.8	2.4		12			160	3.0	0.1	0.1	0.3	0.4	111.7				108.9	108.5
1.12		23	22		1.0	5.7	2.20	0.8	1.9	10	8	13.8		175	1.7	0.1	0.1	0.1	0.2	111.1				109.1	
1.13		24	23		0.5	5.0	2.30	0.8	0.9		8			100	2.5	0.1	0.2	0.2	0.4	112.1				109.5	

TABLE E

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

5 YEAR STORM

AREA "E"

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		27.0	13.4	1.60	0.8	34.6		30			200	7.2	0.8	0.1	0.6	0.7	110.3	111.1			107.6	106.9
2		2	1		21.0	12.8	1.65	0.8	27.7		27			250	7.1	0.8	0.6	0.8	1.4	112.2				109.0	
3		3	2		12.0	12.1	1.70	0.8	16.3		27			175	4.3	0.3	0.2	0.2	0.4	113.5				109.4	
4		4	3		7.0	10.1	1.85	0.8	10.4	15	18	23.4		450	3.5	0.2	0.2	0.5	0.7	112.6				110.1	
5		5	4		4.5	9.5	1.90	0.8	6.8	15	15	21.2		100	2.7	0.1	0.1	0.1	0.2	113.1				110.3	
6		6	5		3.5	8.0	1.95	0.8	5.5	15	12	19.2		250	2.7	0.1	0.2	0.2	0.4	112.5				110.7	
11		7	1		4.0	11.2	1.80	0.8	5.8	15	12	19.2		350	2.8	0.1	0.1	0.3	0.4	113.3				108.0	107.6
12		8	7		3.0	10.0	1.85	0.8	4.4	15				250	3.5	0.2	0.2	0.5	0.7	111.6					
13		23	8		1.5	8.0	1.95	0.8	1.6	12				250	2.1	0.1	0.2	0.2	0.4	113.1					
21		10	2		7.0	12.1	1.70	0.8	9.5		18			75	5.3	0.5	0.4	0.2	0.6	113.1				109.6	109.0
22A		11	10		5.0	11.2	1.75	0.8	7.0	12	15	19.2		175	3.4	0.2	0.2	0.2	0.4	113.1				110.0	
22B		12	11		2.0	10.7	1.80	0.8	2.9		15			75	2.3	0.1	0.1	0.1	0.2	111.9				110.2	
23		13	12		1.5	9.4	1.90	0.8	2.3		12			225	3.0	0.1	0.1	0.4	0.5	111.6				110.7	
24		14	13		1.0	9.1	1.90	0.8	1.5		10			50	2.7	0.1	0.1	0.1	0.2	111.5				110.9	
25		15	14		0.5	8.0	1.95	0.8	0.8		8			150	2.3	0.1	0.2	0.3	0.5	111.6				111.4	
31		19	3		4.0	11.5	1.75	0.8	5.6	12	12	17.0		225	3.4	0.2	0.2	0.3	0.5	113.6				109.9	109.4
32		20	19		2.5	10.0	1.85	0.8	3.7	12	10	15.6		250	2.8	0.1	0.2	0.3	0.5	113.5				110.4	
33			REVERSED TO AREA "F"																						
34			REVERSED TO AREA "F"																						
22A1		17	11		2.5	12.3	1.70	0.8	3.4		15			200	2.7	0.1	0.1	0.2	0.3	111.9				110.3	110.0
22A2		18	17		1.5	11.5	1.75	0.8	2.1		12			125	2.6	0.1	0.1	0.2	0.3	111.2				110.6	
22A3		4	18		1.0	10.0	1.85	0.8	1.5		12			175	2.0	0.1	0.2	0.1	0.3	111.6				110.9	

TABLE F

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

5 YEAR STORM

AREA "F"

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		20.0	16.0	1.50	0.8	24.0		30			250	4.8	0.4	0.2	0.4	0.6	112.1	112.1			107.5	106.9
2		2	1		17.5	14.9	1.55	0.8	21.7		30			275	4.4	0.3	0.1	0.3	0.4	112.1				107.9	
3		3	2		14.0	12.0	1.70	0.8	19.0		27			500	4.7	0.4	0.4	0.7	1.1	112.0				109.0	
4		4	3		2.5	10.0	1.50	0.8	3.0		24			150	0.9	0.1	0.1	0.1	0.2	111.9				109.2	
5		4G (*)	4		0.5	5.0	2.30	0.8	0.9		24			300	0.3	0.1	0.2	0.1	0.3	112.2				109.5	
31		6	3		4.5	12.4	1.70	0.8	6.1		18			275	3.5	0.2	0.1	0.4	0.5	115.0	112.0			109.5	109.0
32		7	6		3.0	11.2	1.80	0.8	4.3		15			260	3.5	0.2	0.2	0.4	0.6	112.6				110.1	
32A		9	7		1.5	10.0	1.85	0.8	2.2	12				200	2.8	0.1	0.2	0.3	0.5	112.6				110.6	
311		10	6		0.5	5.0	2.30	0.8	0.9		10			75	1.6	0.1	0.2	0.1	0.3	113.1				109.8	109.5
41		11	4		1.0	7.0	2.05	0.8	1.6		18			200	0.9	0.1	0.1	0.1	0.2	113.1				109.4	109.2
42		10	11		0.5	5.0	2.30	0.8	0.9		8			300	2.5	0.1	0.2	0.6	0.8	113.1				110.2	
3A		12	3		5.0	11.5	1.75	0.8	7.0		15			130	5.7	0.5	0.3	0.6	0.9	112.6				109.9	109.0
3B		13	12		4.5	10.9	1.80	0.8	6.5	12	12	17		140	4.0	0.3	0.1	0.3	0.4	113.1				110.3	
3C	(***)	21	13		4.0	10.0	1.85	0.8	5.9	15				250	4.8	0.4	0.5	0.8	1.3	113.4				111.6	

(*) - 4G, Manhole 4, Area G

(**) - Deversion from Area E

TABLE 6

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

LEGEND

11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

5 YEAR STORM

AREA "G"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		15.0	15.6	1.45	0.8	17.4		24			200	5.5	0.5	0.2	0.5	0.7	111.7				107.6	106.9
2		2	1		14.0	14.3	1.50	0.8	16.8		24			400	5.3	0.4	0.1	0.9	1.0	113.1				108.6	
3		3	2		11.5	12.4	1.70	0.8	15.6		24			550	4.8	0.4	0.3	1.0	1.3	112.6				109.9	
4		4G	3		8.5	10.7	1.75	0.8	11.9		24			375	3.7	0.2	0.1	0.4	0.5	112.2				110.4	
5		5	4		6.5	9.8	1.85	0.8	9.6		21			200	3.9	0.2	0.1	0.3	0.4	111.6				110.8	
6		6	5		4.0	8.7	1.90	0.8	6.1		18			200	3.4	0.2	0.3	0.3	0.6	111.6				111.4	
7		6	7		Reversed to Area A (new H St. interceptor)																				
61		15	6		2.0	7.0	2.05	0.8	3.3	12	10	15.6		250	2.5	0.1	0.2	0.3	0.5	113.1				111.9	111.4

TABLE H

UTILITIES TECHNICAL STUDY, PHASE II

STORM SEWER SYSTEM

5 YEAR STORM

AREA "H"

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		34.0	17.6	1.35	0.80	36.7		42			220	3.8	0.2	0.10	0.10	0.2	111.7	111.30			107.1	106.9
2		2	1		30.0	16.9	1.40	0.80	33.6		36			200	4.6	0.3	0.10	0.20	0.3	111.2				107.4	
3		3	2		28.0	16.0	1.45	0.80	32.5		36			200	4.6	0.4	0.20	0.20	0.4	111.3				107.8	
4A		4	3		16.0	15.3	1.45	0.80	18.6		30			200	3.7	0.2	0.10	0.20	0.3	109.3				108.1	
4B		5	4		14.0	14.5	1.50	0.80	16.8		27			200	4.1	0.3	0.20	0.20	0.4	111.3				108.5	
5		6	5		10.0	13.0	1.60	0.80	12.8		24			375	3.9	0.2	0.10	0.50	0.6	111.6				109.1	
6		7	6		7.0	11.7	1.70	0.80	9.5		18			425	5.3	0.4	0.10	1.30	1.4	112.4				110.5	
7		8	7		4.0	10.9	1.80	0.80	5.8		15			200	4.7	0.4	0.30	0.60	0.9	112.1				111.4	
8		9	8		2.0	10.0	1.85	0.80	3.0		12			200	3.7	0.2	0.30	0.50	0.8	112.2				112.2	
1.1		10	1		0.5	8.0	1.95	0.80	0.8		15			200	0.7	0.1	0.20	0.10	0.3	111.7				107.4	107.10
1.2		11	1		1.5	8.0	1.95	0.80	2.3		15			300	1.8	0.1	0.20	0.20	0.4	111.6				107.5	107.10
31A		12	3		11.0	14.5	1.50	0.80	13.2		24			150	4.2	0.3	0.20	0.20	0.4	111.2				108.2	107.80
31B		13	12		8.0	13.4	1.60	0.80	10.2		24			225	3.2	0.2	0.10	0.20	0.3	111.2				108.5	
32		14	13		6.0	12.4	1.70	0.80	8.2		21			200	3.4	0.2	0.10	0.20	0.3	111.3				108.8	
33		15	14		4.0	11.4	1.70	0.80	5.4		18			200	3.0	0.1	0.10	0.20	0.3	111.8				109.1	
34		16	15		2.0	10.0	1.85	0.80	3.0		15			200	2.4	0.1	0.20	0.20	0.4	111.4				109.5	
311		17	12		2.0	8.9	1.90	0.80	3.0		12			200	3.8	0.2	0.20	0.60	0.8	111.6				109.0	108.20
312		18	17		1.0	8.0	1.95	0.80	1.6		10			150	2.9	0.1	0.20	0.30	0.5	111.3				109.5	
41		19	5		2.0	12.4	1.70	0.80	2.7		18			200	1.5	0.1	0.10	0.10	0.2	109.1				108.7	108.50
42		20	19		1.0	10.0	1.85	0.80	1.5		15			175	1.2	0.1	0.20	0.10	0.3	107.2	NOTE: WILL FLOOD			109.0	

TABLE I

U T I L I T I E S   T E C H N I C A L   S T U D Y ,   P H A S E   II

STORM SEWER SYSTEM

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

5 YEAR STORM

AREA "I"

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	LOWER END	CROWN ELEVATION UPPER END	LOWER END	HYD. GRADIENTS UPPER END	LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		7.0	12.2	1.70	0.8	9.5		18			75	5.3	0.5	0.2	0.2	0.4	112.1				107.3	106.9
2		2	1		6.2	11.5	1.75	0.8	8.7		18			200	4.9	0.4	0.2	0.6	0.8	111.9				108.1	
3		3	2		3.7	10.7	1.80	0.8	5.3	10	12	15.6		200	4.0	0.3	0.3	0.4	0.7	.111.6				108.8	
4		4	3		2.2	9.2	1.90	0.8	3.3	10	12	15.6		225	2.5	0.1	0.1	0.2	0.3	111.5				109.1	
5		5	4		1.5	7.5	2.00	0.8	2.4	10	10	14.4		200	2.0	0.1	0.2	0.1	0.3	111.6				109.4	
21		2	6		1.5	8.2	1.95	0.8	2.3		10			50	2.9	0.1	0.1	0.1	0.2	112.1				108.3	108.1
22		7	6		1.0	7.5	2.00	0.8	1.6		10			125	2.9	0.1	0.2	0.2	0.4	112.1				108.7	

TABLE J

U T I L I T I E S   T E C H N I C A L   S T U D Y ,   P H A S E   I I

STORM SEWER SYSTEM

5 YEAR STORM

AREA "J"

LEGEND
11a - New and/or Reinforcement Pipe
11b - Existing Pipe(s)
11c - Combined Equivalent Dia.
SLOPE - No Slope Used, because of Pressure Flow Analysis

LINE #	LOCATION	FROM MANHOLE	TO MANHOLE	AREA INCREMENT	(AC) TOTAL	Tc (MM)	I (IN/HR)	C	Q (CFS)	DIA (IN)	DIA (IN)	DIA (IN)	SLOPE	L (FT)	V (FPS)	V2/2g	Hv (FT)	Hl (FT)	H (FT)	GROUND ELEVATION UPPER END	GROUND ELEVATION LOWER END	CROWN ELEVATION UPPER END	CROWN ELEVATION LOWER END	HYD. GRADIENTS UPPER END	HYD. GRADIENTS LOWER END
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11a)	(11b)	(11c)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
1		1	OUTFALL		7.4	8.2	2.00	0.8	11.8		27			100	3.0	0.1	0.1	0.1	0.2	111.9	112.1			107.1	106.9
2		2	1		2.3	7.1	2.05	0.8	3.9		15			200	3.0	0.1	0.1	0.3	0.4	111.8				107.5	
3		3	2		1.6	6.5	2.10	0.8	2.7		12			130	3.4	0.2	0.1	0.3	0.4	112.0				107.9	
4		4	3		1.1	6.0	2.15	0.8	1.9		10			100	3.5	0.2	0.2	0.3	0.5	112.0				108.4	
5		5	4		0.5	5.0	2.30	0.8	0.9		8			150	2.5	0.1	0.2	0.3	0.5	112.2				108.9	
1.1		6	1		1.7	6.7	2.10	0.8	2.9		12			130	3.7	0.2	0.1	0.4	0.5	111.9				107.6	107.1
1.2		7	6		1.0	5.9	2.15	0.8	1.7		10			150	3.1	0.2	0.1	0.4	0.5	111.9				108.1	
1.3		8	7		0.5	5.0	2.30	0.8	0.9		8			130	2.5	0.1	0.3	0.3	0.6	112.0				108.7	
11		9	1		2.9	6.6	2.10	0.8	4.9		15			180	3.9	0.2	0.1	0.4	0.5	110.7				107.6	107.1
12		10	9		1.4	6.0	2.15	0.8	2.4		10			150	4.4	0.3	0.3	0.7	1.0	110.2				108.6	
13		11	10		0.5	5.0	2.30	0.8	0.9		8			150	2.5	0.1	0.2	0.3	0.5	110.1				109.1	

The following is a description of the columns of the storm drain computation tables for the two and five year storm analyses.

Column (1)	This column lists the pipe run number shown on the respective network diagrams
Column (2)	This column lists the general location of the pipe run
Column (3)	This lists the upstream manhole number
Column (4)	This lists the downstream manhole number
Column (5)	Not used
Column (6)	Tributary area in acres draining into a pipe run
Column (7)	Time of concentration in minutes
Column (8)	Rainfall intensity in inches per hour
Column (9)	Runoff coefficient
Column (10)	Runoff in cubic feet per second
Column (11a)	Diameter of <u>new</u> pipe
Column (11b)	Diameter of old (existing) pipe
Column (11c)	Equivalent diameter of new & old pipe
Column (12)	Slope from manhole to manhole - not used because of pressure flow analysis
Column (13)	Length of pipe between manholes in feet
Column (14)	Flow velocity in feet per second
Column (15)	Velocity head in feet ($V^2/2g$)
Column (16)	Energy loss in feet (Hv)
Column (17)	Friction loss in feet (Hl)
Column (18)	Total loss in feet (H=Hv + Hl)
Column (19)	Ground elevation - upper end
Column (20)	Ground elevation - lower end
Column (21)	Elevation top of pipe - upper end
Column (22)	Elevation top of pipe - lower end
Column (23)	Hydraulic grade line elevation - upper end (Hg_U) ($Hg_U = Hg_L + H$)
Column (24)	Hydraulic grade line elevation - lower end (Hg_L)

CONTRACT NO. N62474-86-C-0969

UTILITIES TECHNICAL STUDY, PHASE 2

NAVAL STATION TREASURE ISLAND, HUNTERS POINT ANNEX

SAN FRANCISCO, CA.

VOLUME VI - STORM SEWERAGE SYSTEM

SECTION 8.0 - INDEX

APPENDICES - PART D

PART D — LIST OF DRAWINGS & FIGURES

SYM	REVISIONS DESCRIPTION	DATE	APPROVED

GENERAL LEGEND

- MAJOR BUILDING, PIER
- MINOR BUILDING
- TANK
- CURB
- EDGE OF TRAVELLED WAY
- DIRT ROAD
- CONCRETE
- RAILROAD
- CRANE TRACK
- FENCE
- RETAINING WALL
- GUARDRAIL
- STATION BOUNDARY
- INDEX CONTOUR WITH VALUE
- INTERMEDIATE CONTOUR
- SPOT ELEVATION
- WATERLINE
- LINE SIZE (TYP.) PRE 1958 STORM DRAIN.
- LINE SIZE (TYP.) 1975 STORM SEWER ADDITIONS
- DIVERSION STRUCTURE
- REMOVED OR ABANDONED STORM SEWER
- U.S. BULKHEAD & BOUNDARY LINE

NOTE:

This series of maps was prepared using photogrammetric computer aided mapping techniques from aerial photography dated January 23, 1986 and complies with national map accuracy standards

Horizontal and vertical control was established by Towill Inc. based on the California Coordinate System, Zone 3.
Vertical datum is based on 1929 N G V D.
To convert map elevations to M.L.L.W., add 3.12'.
Station boundary was determined from NAVFAC DWG NO.'s 1046737, 1046708, 1046738.

TRUE N GRID N MAGNETIC N

1°08'31" 17°00'

200 0 200 400 600 800

SCALE IN FEET

SD-1

YEI ENGINEERS, INC.

Villalobos & Associates
Consulting Engineers
3995 Smith Street, Union City CA 94587
Telephone (415) 489-0000

WESTDIV. DWG NO.

COMPILED BY:
DRAWN BY: MD
CHECKED BY: JLY
REVIEWED BY:
HEAD, CADASTRAL SECTION
SATISFACTORY BY:
HEAD, CADASTRAL BRANCH

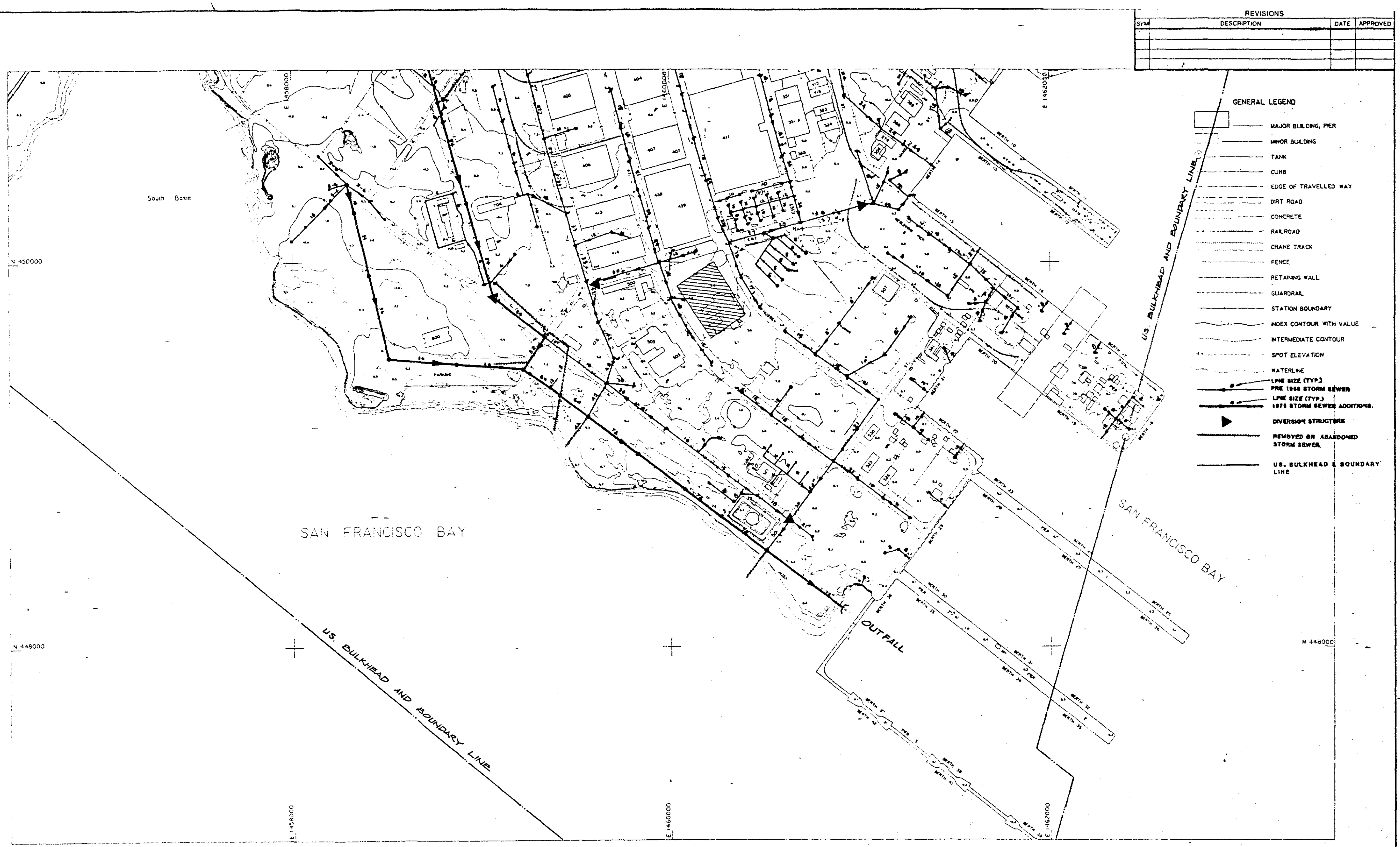
DEPT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION, SAN BRUNO, CALIF.

NAVAL STATION, TREASURE ISLAND–HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

UTILITIES TECHNICAL STUDY, PHASE 2
STORM DRAIN SYSTEM
1987 EXISTING CONDITIONS

SCALE 1" = 200'
SHEET ____ OF ____
NAVFAC DWG. NO.

DIRECTOR REAL ESTATE DIVISION FOR COMMANDER NAVFAC
12/2/88



200 0 200 400 600 800

SCALE IN FEET

SD-2

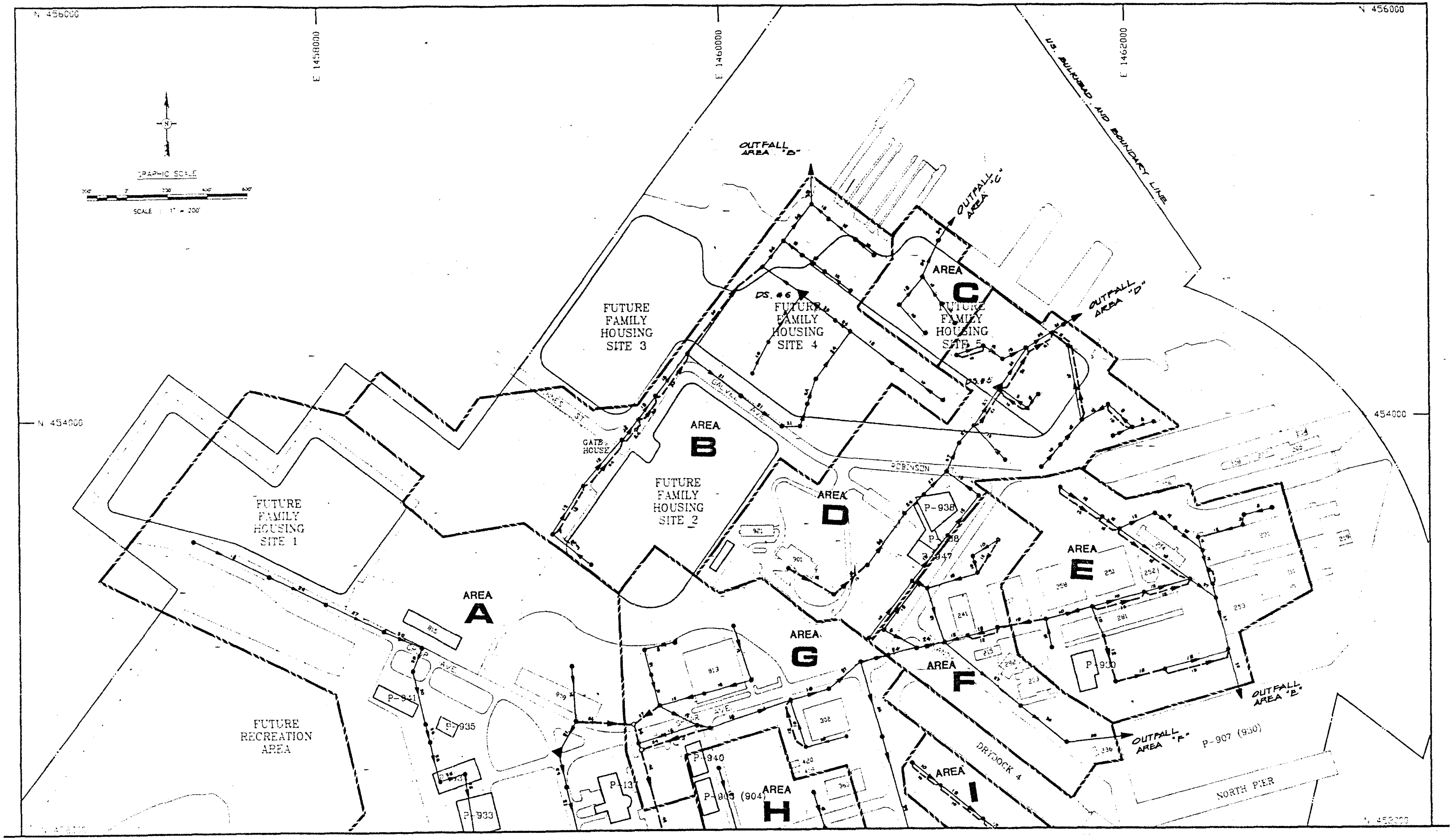
YEI ENGINEERS, INC.	WESTDIV DWG NO.	DEPT OF THE NAVY NAVAL FACILITIES ENGINEERING COMMAND WESTERN DIVISION, SAN BRUNO, CALIF.
	COMPILED BY:	NAVAL STATION, TREASURE ISLAND-HUNTERS POINT ANNEX SAN FRANCISCO, CALIFORNIA
	DRAWN BY MD	UTILITIES TECHNICAL STUDY, PHASE 2
	CHECKED BY JLV	STORM DRAIN SYSTEM
Villalobos & Associates Consulting Engineers 3085 Smith Street, Union City CA 94587 Telephone (415) 486-6660	REVIEWED BY HEAD, CADASTRAL SECTION SATISFACTORY BY: HEAD, CADASTRAL BRANCH	1987 EXISTING CONDITIONS
	DIRECTOR REAL ESTATE DIVISION FOR COMMANDER NAVFAC	SCALE: 1" = 200' SHEET ___ OF ___
	2/2/88	NAVFAC DWG. NO.

NOTE:

This series of maps was prepared using photogrammetric computer aided mapping techniques from aerial photography dated January 25, 1986 and complies with national map accuracy standards.

Horizontal and vertical control was established by Towill Inc based on the California Coordinate System, Zone 3.
Vertical datum is based on 1929 N.G.V.D.
To convert map elevations to M.L.L.W., add 3.12'
Station boundary was determined from NAVFAC DWG NO.'s 1045757, 1045758, 1045759.

REVISIONS				
SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED



MATCH LINE

LEGEND

SIZE
EXISTING STORM SEWER

SIZE
PROPOSED ADDITION STORM SEWER

DIVERSION BOX

DRAINAGE AREA

FLOW IN EITHER DIRECTION DEPENDING ON HYDRAULIC BALANCE.

US. BULKHEAD AND BOUNDARY LINE

IF SHEET IS LESS THAN 28" X 40" IT IS A REDUCED PRINT — SCALE REDUCED ACCORDINGLY

SD-3

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SUPV. | CH. ENGR.
SUBMITTED BY | DATE 12/2/88
E.I.C. | FIRE PROT.
BR. HD. | DIR.
SATISFACTORY TO | DATE
APPROVED | DATE

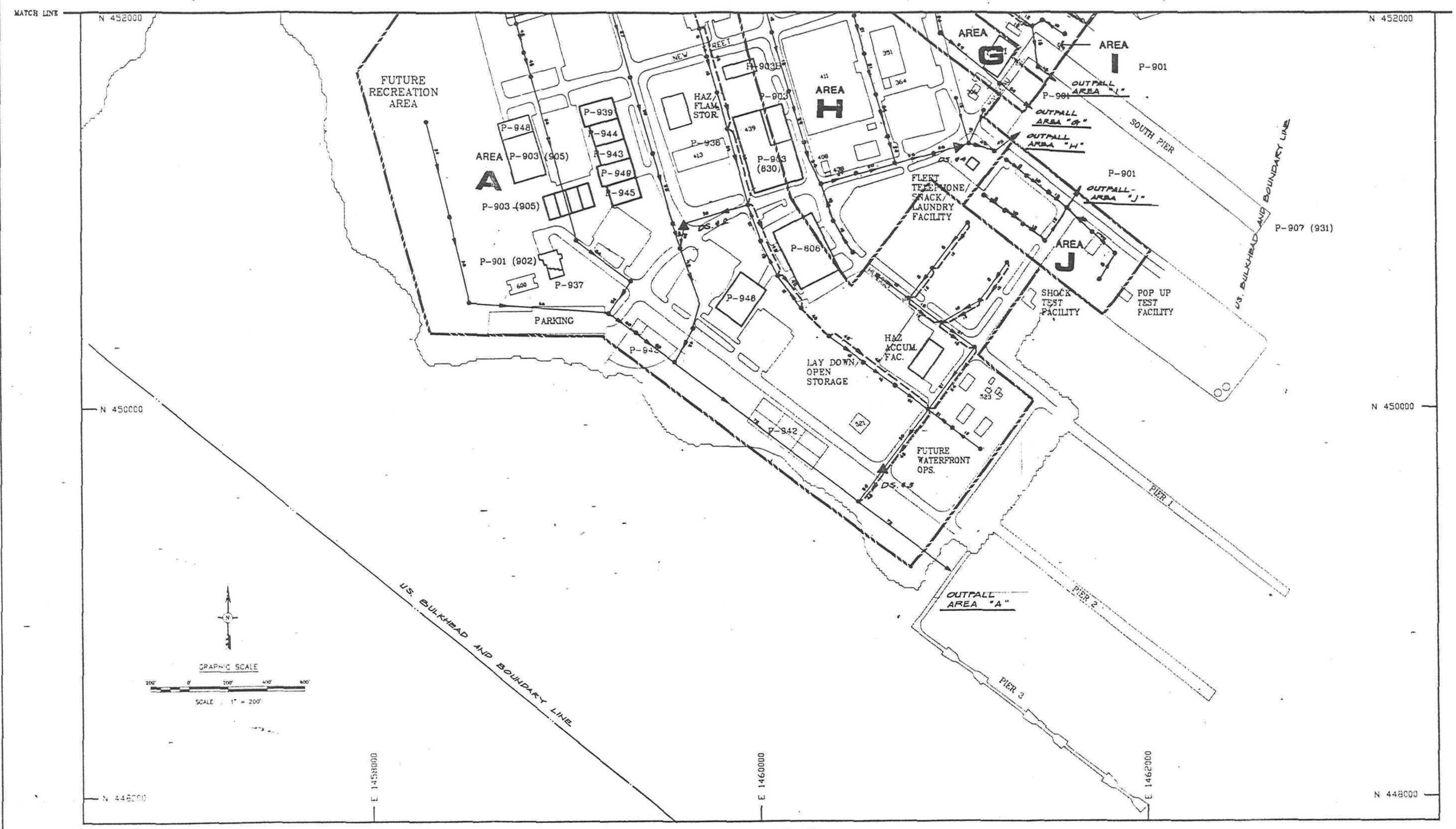
DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

NAVAL STATION, TREASURE ISLAND–HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

UTILITIES TECHNICAL STUDY, PHASE 2
STORM DRAIN SYSTEM FUTURE CONDITIONS

SIZE F | CODE IDENT. NO. 80091 | NAVFAC DRAWING NO.
SCALE NOTED | SPEC. | SHEET OF

SYM	DESCRIPTION	PREP'D BY	DATE	APPROVED



LEGEND

- SIZE EXISTING STORM SEWER
- SIZE PROPOSED ADDITION STORM SEWER
- DIVERSION BOX
- DRAINAGE AREA
- U.S. BULKHEAD AND BOUNDARY LINE

IF SHEET IS LESS THAN 28" X 40" IT IS A REDUCED PRINT — SCALE REDUCED ACCORDINGLY

SD-4

YEI ENGINEERS, INC.

Villalobos & Associates
Consulting Engineers

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SUPV.		CH. ENGR.
SUBMITTED BY		DATE 12/2/90
E.I.C.	FIRE PROT.	
BR. NO.	DIR.	
SATISFACTORY TO		DATE
TITLE		
APPROVED		DATE

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND
WESTERN DIVISION
SAN BRUNO, CALIFORNIA

NAVAL STATION, TREASURE ISLAND—HUNTERS POINT ANNEX
SAN FRANCISCO, CALIFORNIA

UTILITIES TECHNICAL STUDY, PHASE 2
STORM DRAIN SYSTEM
FUTURE CONDITIONS

SIZE	CODE IDENT. NO.	NAVFAC. DRAWING NO.	
F	80091	CONST. CONTR. NO.	
SCALE NOTED		SPEC.	SHEET OF

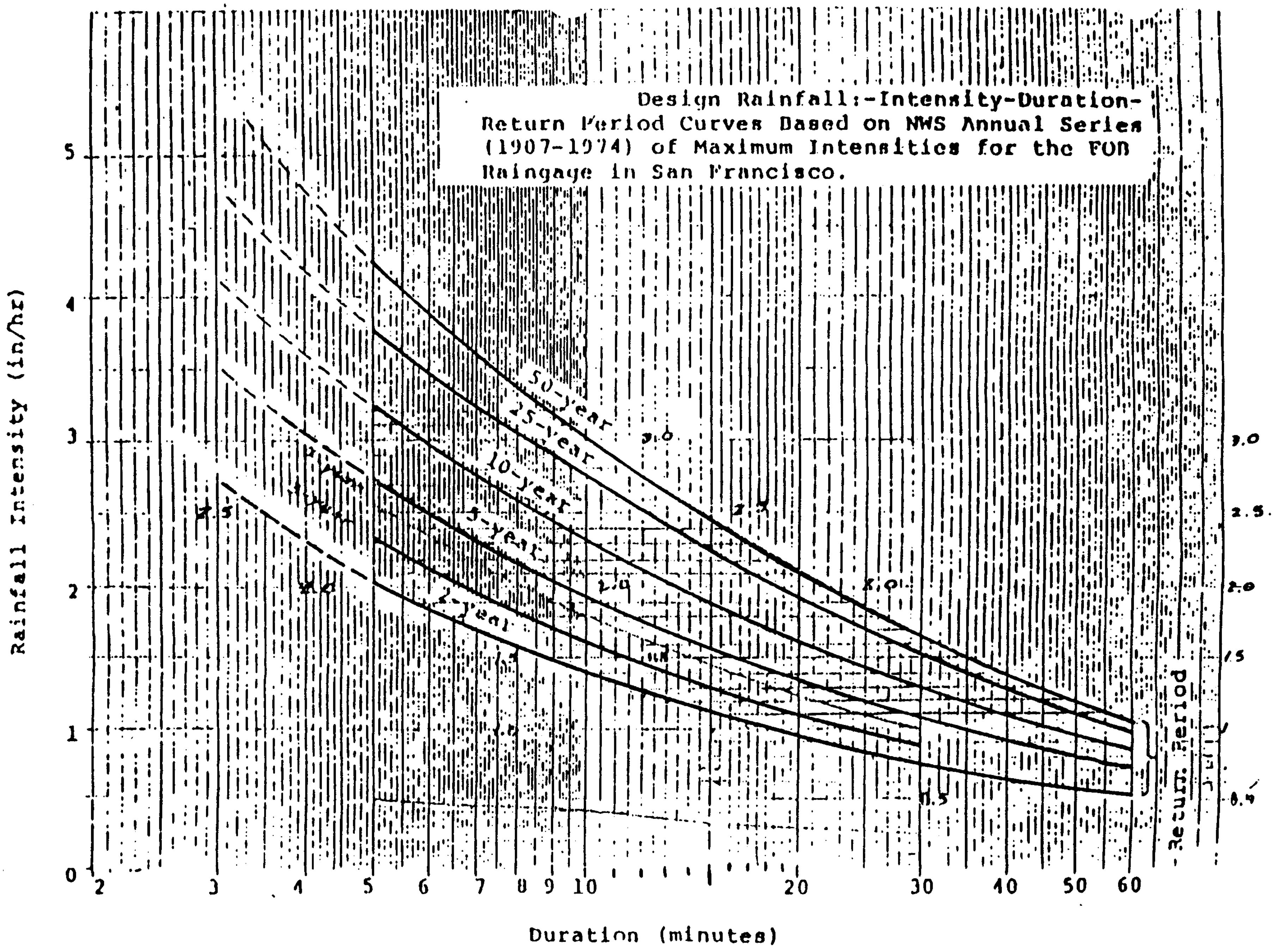
Design Rainfall:-Intensity-Duration-Return Period Curves Based on NWS Annual Series (1907-1974) of Maximum Intensities for the FOB Raingage in San Francisco.
Rainfall Intensity (in/hr)
Duration (minutes)
Return Period
50-year
25-year
10-year
5-year
2-year
0
1
2
3
4
5
2
3
4
5
6
7
8
9
10
20
30
40
50
60

FIGURE 6-1

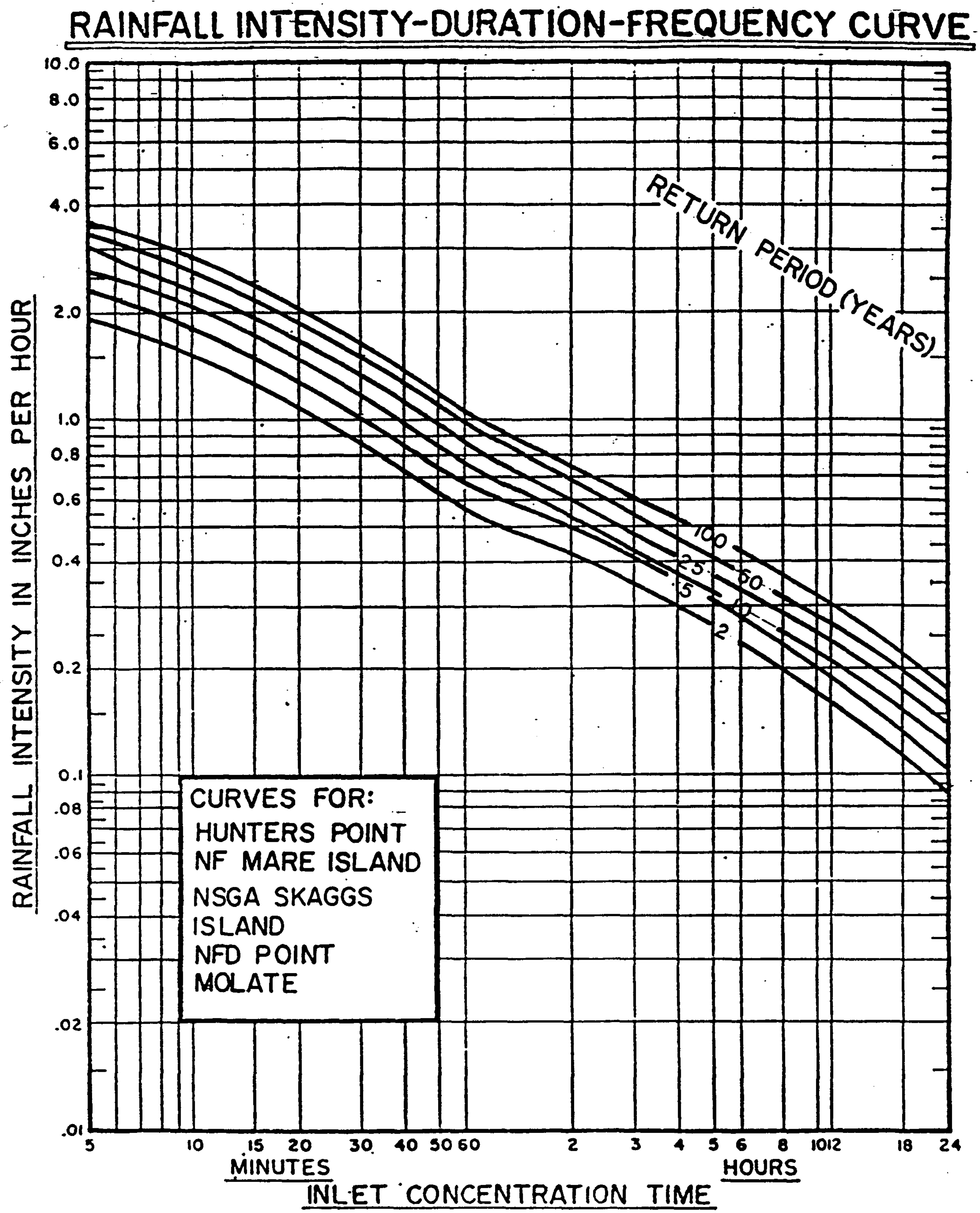
RAINFALL INTENSITY-DURATION-FREQUENCY CURVE
RAINFALL INTENSITY IN INCHES PER HOUR
10.0
8.0
6.0
4.0
2.0
1.0
0.8
0.6
0.4
0.2
0.1
.08
.06
.04
.02
.01
RETURN PERIOD (YEARS)
100
50
25
10
5
2
CURVES FOR:
HUNTERS POINT
NF MARE ISLAND
NSGA SKAGGS
ISLAND
NFD POINT
MOLATE
5
10
15
20
30
40
50
60
2
3
4
5
6
8
10
12
18
24
MINUTES
HOURS
INLET CONCENTRATION TIME

Figure 6-2